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U.S. Army Center for Health Promotion and Preventive Medicine

**TRAINING MUNITIONS HEALTH RISK
ASSESSMENT
NO. 39-EJ-1485-00
RESIDENTIAL EXPOSURE FROM INHALATION OF
AIR EMISSIONS FROM FIRING OF THE
M301A3 81-MM ILLUMINATING CARTRIDGE
DEPARTMENT OF DEFENSE IDENTIFICATION CODE: C226**

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Readiness Thru Health

U.S. Army Center for Health Promotion and Preventive Medicine

The U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) lineage can be traced back over 50 years. This organization began as the Army Industrial Hygiene Laboratory, established during the industrial buildup for World War II, under the direct supervision of The Army Surgeon General. Its original location was at the Johns Hopkins School of Hygiene and Public Health. Its mission was to conduct occupational health surveys and investigations within the Department of Defense's (DOD's) industrial production base. It was staffed with three personnel and had a limited annual operating budget of \$3,000.

In 1960, the laboratory became internationally known as the U.S. Army Environmental Hygiene Agency or AEHA. Its mission expanded to support the worldwide preventive medicine programs of the Army, DOD, and other Federal agencies when directed by the Army Medical Command or the Office of The Surgeon General, through consultations, support services, investigations, on-site visits, and training.

On 1 August 1994, AEHA was redesignated the U.S. Army Center for Health Promotion and Preventive Medicine with a provisional status and a commanding general officer. On 1 October 1995, the nonprovisional status was approved with a mission for providing preventive medicine and health promotion leadership, direction, and services for America's Army.

The mission of USACHPPM is to provide health promotion and preventive medicine leadership and services to counter environmental, occupational, and disease threats to health, fitness, and readiness in support of the National Military Strategy. Its vision is to be the world class center of excellence for the systematic prevention of environmental, occupational, and disease threats to the health performance of individuals and populations.

The Center has been reorganized and reengineered to support the Army of the future. The USACHPPM now has three subordinate commands located in Fort Meade, Maryland; Fort McPherson, Georgia; and Fort Lewis, Washington; to provide responsive regional health promotion and preventive medicine support across the U.S. There are also two CHPPM overseas commands in Landstuhl, Germany and Camp Zama, Japan who contribute to the success of USACHPPM's increasing global mission.

The USACHPPM remains strong and at the forefront of prevention-based programs worldwide. The future will involve meeting multiple challenges, from demonstrating the effectiveness of health promotion and preventive medicine to integrating force health protection, health risk assessment, population health and injury prevention into the life-cycle model of the soldier. The USACHPPM will continue to work closely with sister services to support the continuum of military operations to be faced in the coming years.

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14. ABSTRACT This assessment evaluated the potential for human health effects to offsite residents breathing air emissions following use of the M301A3 81-MM Illuminating Cartridge. This document presents the evaluation of the potential for adverse human health effects to the offsite residents breathing air emissions following the use of military firing ranges during training exercises. Study results showed no potential for health risks to the hypothetical resident from inhalation of air emissions from the .81 Illuminating Cartridge. To conduct this study, air emissions from the .81 Illuminating Cartridges were collected in a test chamber (at Aberdeen Test Center, Aberdeen, MD). This information was then used in an air dispersion model to determine ambient air concentrations at a location downwind from the site where the item was activated. Modeled air concentrations were combined with exposure information to estimate the amount of substances the hypothetical resident breathes. This intake was combined with the substance's health information, to determine if there is a potential for health risks from inhalation of these substances. The health risk included both long-term and short term exposures to the modeled substance concentrations. Study results showed no potential for health risks from inhalation of air emissions from the .81 Illuminating Cartridge.						
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TRAINING MUNITIONS HEALTH RISK ASSESSMENT NO. 39-EJ-1485-00
RESIDENTIAL EXPOSURE FROM INHALATION OF AIR EMISSIONS
FROM FIRING OF THE M301A3 81-MM ILLUMINATING CARTRIDGE

EXECUTIVE SUMMARY

This assessment evaluated the potential for human health effects to offsite residents breathing air emissions following firing of the M301A3 81-mm Illuminating Cartridge (M301A3) during training exercises.

To conduct this assessment, air emissions from the M301A3 were collected in a test chamber at the U.S. Army Aberdeen Test Center, Maryland. The data collected from the Firing Point Emission Study provided the amount and types of substances released from the M301A3 when it is fired. This information was then used in an air dispersion model to determine ambient air concentrations at a location 100 meters (328 feet) downwind from a site where the M301A3 may be used. Since the training facility in this assessment is hypothetical, the air model used assumptions that provided conservative estimates of air concentrations.

Modeled air concentrations were combined with exposure information (e.g., number of cartridges used per year) to estimate the amount of each substance the hypothetical offsite resident breathes. This estimate was then compared with the substance's health based screening level, which was obtained from agencies such as the U.S. Environmental Protection Agency, to determine if there is a potential for health effects from inhalation of these substances.

The health risk assessment included both long-term and short-term exposures to modeled substance concentrations. Assessment results, generated using conservative methods, showed that the hypothetical offsite resident breathing air as close as 100 meters from the M301A3 firing location is safe from these emissions. It should be noted that at most training installations, training areas are over 1,000 meters (over half a mile) away from populated areas.

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LIST OF ACRONYMS

AEC	U.S. Army Environmental Center
AEGL	Acute Exposure Guideline Levels
AIHA	American Industrial Hygiene Association
ATC	U.S. Army Aberdeen Test Center
ATV	Acute Toxicity Value
DOE	U.S. Department of Energy
DODIC	Department of Defense Identification Code
EPA	U.S. Environmental Protection Agency
ERPG	Emergency Response Planning Guidelines
HBSL	Health-Based Screening Level
INPUFF	Integrated PUFF Model
NAAQS	National Ambient Air Quality Standards
NEW	Net Explosive Weight
OEL	Occupational Exposure Limit
PM ₁₀	Particulate Matter under 10 microns in size
PRG	Preliminary Remediation Goals
RBC	Risk-Based Concentration
RfC	Reference Concentration
TEEL	Temporary Emergency Exposure Limits
TPH	Total Petroleum Hydrocarbons
TSP	Total Suspended Particulates
USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine

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RESIDENTIAL EXPOSURE FROM INHALATION OF AIR EMISSIONS FROM FIRING
OF THE M301A3 81-MM ILLUMINATING CARTRIDGE

1. PURPOSE

This document presents the assessment of the potential for human health effects to offsite residents breathing air emissions following firing of the M301A3 81-mm Illuminating Cartridge (M301A3) during training exercises.

2. AUTHORITY

Statement of Work, 30 November 2000, Training Munitions Inhalation Health Risk Evaluations.

3. REFERENCES

See Appendix A for a list of references.

4. BACKGROUND

4.1 CARTRIDGES AND THEIR USE

Cartridges are cases that contain a primer, propelling charge, and projectile. The primer is needed to activate the propelling charge, which provides the force to send the projectile to a target. Examples of projectiles include bullets, rockets, and missiles. Cartridges are also referred to as "rounds" and are fired from weapons such as pistols or rifles. The use of cartridges with weapons during training activities is important in preparing our soldiers for a variety of combat situations.

4.2 WHAT IS THE M301A3 81-MM ILLUMINATING CARTRIDGE?

The M301A3 cartridge is used during training and combat for illuminating a desired point or area. The complete cartridge consists of a body tube and tail cone assembly, an illuminant candle and parachute assembly, a time fuze with a built-in expelling charge, a fin assembly with a cartridge housing and propellant increment charges, and an ignition cartridge with percussion primer. Each M301A3 cartridge provides illumination for at least 60 seconds (Reference 1).

4.3 ASSESSMENT SUMMARY

The M301A3 was evaluated using an approach consisting of two main parts: air dispersion modeling and exposure assessment, which are briefly discussed in the paragraphs below. Sections 5 through 7 present a discussion of the methodology used for this assessment.

Emissions data used in the air dispersion modeling were obtained from the Firing Point Emission Study, conducted by the U.S. Army Aberdeen Test Center (ATC), at

Aberdeen Proving Ground, Maryland (Reference 2). This study was funded by the U.S. Army Environmental Center (AEC) with the purpose of identifying and quantifying emissions from weapons firing. Data for this study were generated by firing munitions in a test chamber using weapons that are representative of those used by the U.S. Army during training. Emissions data for the M301A3 were generated by firing it from an M252 mortar using one propellant charge increment.

The emissions data for the M301A3 were used with an atmospheric dispersion model to estimate the average concentrations that may be experienced by an offsite resident. Since this assessment is designed to provide results that would be applicable to most Army training facilities, the training area used in this assessment was a hypothetical one. While most training areas are at least 1,000 meters away from populated areas, as a conservative distance, it was assumed that a person could reside 100 meters downwind from the firing point (location where the mortar is positioned). In addition, air-modeling parameters were selected to mimic worst-case conditions.

The exposure assessment included calculations of time-averaged concentrations for both long-term (chronic) and short-term (acute) exposures. Using a screening approach, a substance's estimated time-averaged air concentration was then compared to a chronic health-based screening level (HBSL) selected from sources established by the U.S. Environmental Protection Agency (EPA) and an acute toxicity value (ATV) selected from levels established by selected agencies (depending on the exposure duration). The terms HBSL and ATV are used for the purposes of this assessment. The comparison was made using the ratio of the HBSL or ATV to the estimated air concentration for each of the substances evaluated. If this ratio was less than one, no further evaluation was needed. This approach is conservative because the exposure assumptions used by the agencies to establish HBSLs and ATVs are likely to overestimate the exposures experienced by offsite residents living near firing ranges. If the chronic or acute averaged concentrations (C_{chronic} or C_{acute}) were greater than these screening levels, further analysis would be warranted to determine the potential for health effects. Note that concentrations greater than the screening levels do not indicate an onset of health effects, but rather the potential for such.

5. DATA COLLECTION AND AIR MODELING

5.1 EMISSION FACTORS

Emission factors, used to derive the air modeling emission rates used in this assessment, were generated from the Firing Point Emission Study conducted by the ATC (Reference 2). This study identified and quantified air emissions from the firing of training munitions. The data included the net explosive weight (NEW), the substances sampled, and substance-specific emission factors. Emissions data from the Firing Point Emission Study are included in the first six columns of the table located in Appendix B.

5.2 BACKGROUND AND DESCRIPTION

Air dispersion models are available to mathematically simulate plume behavior and to estimate downwind concentrations of substances emitted from various sources.

However, specific models are not available to determine the dispersion of emissions from munitions used during training. Estimating the magnitude and location of these concentrations depends on many factors including the amount and type of emissions, the behavior of the source, and meteorological conditions. Since a specific model is not available for modeling the use of munitions during training, the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) evaluated numerous air models to determine which would be suitable for use with munitions used during training. The USACHPPM recommended using the Integrated PUFF (INPUFF) model to estimate the dispersion of emissions from various munitions sources (Reference 3).

The INPUFF Model (Reference 4) was developed to simulate dispersion from instantaneous or semi-continuous point sources. This Gaussian-integrated puff model is capable of addressing a cloud type release over short periods of time, and computations can be performed for a single point source for multiple receptors. The algorithms used to calculate concentrations assume a vertically uniform wind direction (with no chemical reaction) to compute the contribution of each cloud at a receptor for each time step/interval.

5.3 MODEL ASSUMPTIONS

Some assumptions were made to best represent the firing of the M301A3 and are included below. The emissions factors and modeling are based on the firing of the M301A3 and do not consider potential emissions generated from the down range functioning of the item. These types of emissions may be evaluated separately in the Exploding Ordnance Emission Study.

- Typically, with conventional point sources (such as incinerators), the cloud rise and formation are determined by characterizing flue gas exit velocity, temperature, and stack diameter. However, the M301A3 is fired from a mortar launch tube. For unconventional sources with no real physical stack dimensions, the stack height and diameter were assumed to equal the height of the launch tube and the diameter, respectively. No exit velocity was used with this source because the emission rates generated from the test data were obtained from sampling a stabilized cloud with no exit velocity. Table 1 includes the source parameters used to model the M301A3.

TABLE 1: SOURCE PARAMETERS

Parameter	Model Input
Source/Stack Diameter	0.081 meters
Source/Stack Height	1 meter
Source Exit Temperature	298.15 degrees Kelvin ($^{\circ}$ K) (or 77 $^{\circ}$ F)
Exit Velocity	0 meters/second
Initial horizontal dispersion coefficient (σ_y)	2.29 meters
Initial vertical dispersion coefficient (σ_z)	1.07meters

- Initial cloud dimensions are preferred to model the air emissions from these types of releases as a volume source. Typically, these dimensions are used to define the initial horizontal and vertical dispersion values (σ_y and σ_z) of the released cloud. However, this information was not measured during the studies at the ATC; therefore, the cloud dimensions were based on the test chamber dimensions and the volume of air sampled. By assuming an elliptical cloud with the prevailing wind direction being perpendicular to the mortar when fired, the test chamber's radius would be equal to the initial vertical dispersion (σ_z), and the initial horizontal dispersion (σ_y), would be equal to one half the length of the test chamber. The cloud exit temperature was assumed to be equal to the test chamber temperature.
- For the purposes of this assessment, a hypothetical offsite resident was assumed to be located 100 meters directly downwind from the source. The meander of the cloud is a major factor when estimating concentrations at given locations downwind from the source. Assuming that the resident is directly downwind from the source is the same as assuming that there is no cloud meander and the center of the cloud migrates directly over the hypothetical offsite resident. This assumption provides the most conservative modeled concentrations.
- Since this assessment does not look at a specific training site, generic, worst-case meteorological data were used. To determine the worst-case meteorological conditions that would result in the highest air emission concentrations, the modeling was performed using the EPA Risk Management Program Guidance (Reference 5). This guidance includes tables for estimating the footprint of chemical releases and is intended to inform emergency responders of potential accidental releases. The EPA has defined most default conditions for meteorological modeling parameters. Table 2 lists the meteorological parameters that were used in the air model.

TABLE 2: WORST-CASE METEOROLOGICAL PARAMETERS

Parameter	Input Value
Wind Speed	1 meter/second
Atmospheric Stability	Category F
Wind Direction	270°
Ambient Temperature	293 degrees Kelvin (°K) (or 68 °F)

5.4 GENERAL METHODOLOGY

The model was run for a total calculation time of 200 seconds to ensure that the total mass of the cloud had passed the hypothetical resident location. Concentrations were calculated every 2 seconds. The model results indicated that the initial cloud reached the hypothetical offsite resident within 72 seconds and dissipated below the lowest concentration the model calculated, which in this instance ($1 \times 10^{-11} \text{ g/m}^3$)

occurred within 148 seconds. Table 3 contains the air model input parameters used in this assessment.

TABLE 3: AIR MODEL INPUT PARAMETERS

Parameter	Input Value
Number of meteorological periods (NTIME)	1
Duration of each meteorological period (ITIME)	200 seconds
Number of updates to the source (NSRCDS)	100
Duration/time step between each source update (ISUPDT)	2 seconds
Total time modeled/Simulation Period (NTIME) (ITIME)= (NSRCDS) (ISUPDT)	200 seconds

5.5 USE OF MODEL OUTPUT

The concentrations provided by the INPUFF model were based on a unit emission rate (ER_{unit}) of 1 gram/second from an emission source, and did not represent any substance-specific concentrations from the use of any weapons system. This unit emission rate is typically used for ease of modeling purposes. The relationship between the emission rate and predicted concentration is linear. Therefore, the ratio of the predicted concentration to the unit emission rate was multiplied by each substance-specific emission rate to provide substance-specific concentrations.

5.6 DETERMINATION OF SUBSTANCE-SPECIFIC EMISSION RATES

The actual substance emission rate for one item (ER_1) for each substance was calculated using Equation 1. Example 1 contains a sample calculation using this equation.

$$ER_1 = \frac{EF \cdot CV}{t} \quad \text{Equation 1}$$

Where:

- ER_1 = emission rate for one item (g/item)/sec
- EF = average adjusted emission factor (lb/item)
- CV = conversion factor (453.59 g/lb)
- t = release duration obtained from the INPUFF model (sec)

Example 1

Sample Calculation Using Equation 1:

$$ER_1 = \frac{(4.09E - 05) (453.59)}{(2)}$$

$$= 9.28E-03 \text{ g/sec/item}$$

Calculation provided for benzene. Appendix B provides the average adjusted emission factor (EF) in lb/item.

Substance-specific ambient concentrations for one item (CONC) were calculated using Equation 2. A sample calculation using this equation is provided in Example 2. Appendix B contains the estimated air concentrations.

$$CONC = ER_1 \cdot \frac{UC}{ER_{unit}} \quad \text{Equation 2}$$

Where:

CONC = substance concentration based on one item (g/m³)

ER₁ = emission rate for one item (g/sec)

ER_{unit} = unit emission rate as used in the model (g/sec)

UC = concentration based on the unit emission rate (g/m³)

Example 2

Sample Calculation Using Equation 2:

$$CONC = (9.28E - 03) \frac{(1.636E - 04)}{(1)}$$

$$= 1.52 E-06 \text{ g/m}^3$$

Calculation provided for benzene.

6. RISK ASSESSMENT

6.1 EXPOSURE ASSUMPTIONS

Exposure assumptions were selected using a typical use scenario for the M301A3. The typical use scenario was provided by the AEC and is based on consultation with their senior training advisor (References 6, 7). The frequency of use for the M301A3 was required to determine how much substance an offsite resident would be exposed to in the time period of interest (i.e., acute or chronic exposure). Table 4 summarizes the general use scenario for the M301A3.

TABLE 4: FREQUENCY OF USE FOR THE M301A3 81-MM ILLUMINATING CARTRIDGE

Parameter	Value Used
Number of cartridges used per year	648
Maximum number of cartridges used in 1-hour	25

6.2 TIME-AVERAGING

For the chronic assessment, time-averaged concentrations were calculated by assuming that the hypothetical offsite resident would be exposed for 30 years. This is consistent with the exposure duration used by the EPA, which assumes that the resident spends 30 years at the same residence. By using the same exposure duration, the estimated time-averaged concentrations could be compared with their respective HBSLs, which are derived using standard EPA default assumptions.

Using the default residence time established by the EPA, the assumption was made that someone could be exposed to air emissions from 648 cartridges per year for 30 years. Table 5 lists the exposure parameters used to estimate concentrations for the chronic assessment. These parameters are based on the typical use scenario provided by the AEC (Table 4) and the assumptions used in the air model run.

TABLE 5: EXPOSURE PARAMETERS USED TO DETERMINE TIME-AVERAGED CHRONIC AIR CONCENTRATIONS

Exposure Parameter	Value Used
Exposure Time (ET _{ctg})	3.333 min/cartridge ¹
Exposure Frequency (EF _{ctg})	648 cartridges/year
Exposure Duration (ED)	30 years ²
¹ Based on the total model time of 200 seconds (3.33 minutes) used in the air model run.	
² EPA default value.	

Chronic averaged concentrations were calculated using Equation 4. Example 4 shows how this calculation was performed. Since benzene is classified as a carcinogen, as indicated in Appendix C, the averaging time (AT) is 70 years.

$$C_{\text{chronic}} = \frac{\text{CONC} \cdot 10^6 \cdot ET_{\text{ctg}} \cdot EF_{\text{ctg}} \cdot ED}{525,600 \cdot AT} \quad \text{Equation 4}$$

Where:

- C_{chronic} = average chronic concentration ($\mu\text{g}/\text{m}^3$)
- CONC = average modeled concentration for one cartridge (g/m^3)
- 10^6 = unit conversion ($\mu\text{g}/\text{g}$)
- ET_{ctg} = exposure time per cartridge (minutes/cartridge)
- EF_{ctg} = exposure frequency (cartridges/year)
- ED = exposure duration (years)
- 525,600 = unit conversion (minutes/year)
- AT = averaging time (years)
- (Carcinogenic endpoint: AT = 70 years)
- (Noncarcinogenic endpoint: AT = ED)

Example 4
Sample Calculation Using Equation 4:

$$C_{\text{chronic(benzene)}} = \frac{(1.52\text{E} - 06)(10^6)(3.333)(648)(30)}{(525,600)(70)}$$

$$= 2.67\text{E}-03 \mu\text{g}/\text{m}^3$$

The average modeled concentration for one cartridge (CONC) was obtained from Appendix B. The exposure parameters were obtained from Table 5.

Since many cartridges may be fired in a short period of time, acute exposures cannot be overlooked. Unlike the chronic assessment, only limited guidance for evaluating acute exposures is currently available. For the purpose of this assessment, acute exposure is defined as a 1-hour or 15-minute exposure. The 1-hour or 15-minute acute exposure averaging times allow for comparison with guidelines developed specifically for emergency planning purposes (see discussion on acute toxicity below).

The exposure frequency is based on the number of cartridges used per 1-hour or 15 minutes depending on the guideline used for comparison. This information is based on the use scenario provided by the AEC (Table 4). To estimate air concentrations for potential acute health impacts, it was conservatively assumed that 25 M301A3

cartridges are fired in 1-hour. The average acute concentrations were computed using Equation 5. Example 5 contains a sample calculation using this equation. Benzene is used as the example substance.

$$C_{acute} = \frac{CONC \cdot 10^6 \cdot ET_{ctg} \cdot EF_{ctg}}{60} \quad \text{Equation 5}$$

Where:

- C_{acute} = average acute concentration ($\mu\text{g}/\text{m}^3$)
- CONC = average modeled concentration for one cartridge (g/m^3)
- 10^6 = unit conversion ($\mu\text{g}/\text{g}$)
- ET_{ctg} = exposure time per cartridge (minutes/cartridge)
- EF_{ctg} = exposure frequency (cartridges/hour)*
- 60 = unit conversion (minutes/hour)
- * Based on 1-hour or 15 minute (0.25 hour) ATV

Example 5
Sample Calculation Using Equation 5:

$$C_{acute(benzene)} = \frac{(1.52E-06)(10^6)(3.333)(25)}{60}$$

$$= 2.11E+00 \mu\text{g}/\text{m}^3$$

The average modeled concentration for one cartridge (CONC) for benzene was obtained from Appendix B. See Appendix C to determine the ATV used.

6.3 TOXICITY ASSESSMENT

The potential for health effects was determined by comparing time-averaged air concentrations to HBSLs, which are developed from a substance's known toxicity. These toxicity values typically include different levels of safety factors depending on the level of confidence of the critical study. Appendix C contains a table of screening levels used for the chronic and acute assessments.

6.3.1 CHRONIC ASSESSMENT

The chronic assessment was conducted using a screening approach. Using this method, a substance's estimated time-averaged air concentration was compared to its HBSL. If this ratio was less than one, no further analysis was needed. This approach is conservative because the exposure assumptions used by the EPA, to establish HBSLs, assume that the resident is exposed for 350 days per year (assuming 2 weeks vacation per year). In contrast, exposure to air emissions from actual training activities at a firing range is intermittent and is not likely to occur on a daily basis year round.

A hierarchy of sources was developed for selection of the HBSLs to quantitatively evaluate as many of the identified substances as possible. The hierarchy of sources used was as follows:

- Clean Air Act, EPA National Ambient Air Quality Standards (NAAQS) (Reference 8)
- EPA Region 9 Preliminary Remediation Goals (PRGs) (Reference 9)
- EPA Region 3 Risk-Based Concentrations (RBCs) (Reference 10)

Some substances have neither PRGs nor RBCs because they have their own set of regulatory standards. Under the Clean Air Act, the EPA is required to establish NAAQS for several substances considered harmful to public health and the environment. Currently, NAAQS are available for seven substances. Different averaging times are available for some substances. The NAAQS for the longer averaging time were used for the chronic assessment. Depending on the substance, this can range from an 8-hour average to an annual average. In addition, since the majority of the measured total suspended particulates (TSP) were PM₁₀ (particulate matter under 10 microns in size) (Reference 2), the NAAQS for PM₁₀ was used to evaluate the potential for health effects from exposure to TSP.

Next on the hierarchy, after the NAAQS, are the EPA Region 9 PRGs and the EPA Region 3 RBCs. The methodology used by EPA Region 9 to develop the PRGs generally results in lower values than the EPA Region 3 RBCs. However, there were occasions when the RBCs were lower than the PRGs. To maintain a conservative approach for this assessment, the lower of the two values from these sources was selected as the HBSL for each substance evaluated. If only one value was available from these sources it was selected as the HBSL. To ensure that the most recent information was used, the Internet sites of both EPA Regions were checked. Appendix C presents the HBSLs used for this assessment.

Although the general approach used by both EPA Region 3 and Region 9 is the same, the exposure assumptions differ enough so that final recommended values can vary to a certain degree. In both methods, a substance's screening concentration was selected using the toxicity endpoint that derives a lower concentration. For example, if a substance has a known systemic toxicity and is a carcinogen, the screening concentration was calculated using both toxicity values. To maintain a conservative approach, EPA then selected the lower screening concentration as the recommended PRG or RBC.

Example 6 shows a sample calculation of how benzene's estimated chronic concentration was compared to its HBSL.

Example 6

Sample Calculation Comparing a Substance's Estimated Chronic Concentration to Its HBSL:

$$\frac{C_{\text{chronic(benzene)}}}{\text{HBSL}} = \frac{2.67\text{E} - 03}{2.16\text{E} - 01}$$

$$= 1.24\text{E} - 02 < 1$$

In this case, the resulting ratio is less than one, indicating further evaluation is not necessary.

Many petroleum hydrocarbons were detected but do not have specific screening levels. Therefore, the approach recommended by the Total Petroleum Hydrocarbon Criteria Working Group (Reference 11) was adopted to evaluate petroleum hydrocarbon mixtures. Based on the working group's assessment of various hydrocarbons, it was recommended that mixtures be separated according to a substance's number of carbons and its chemical class (i.e., aliphatic or aromatic¹). Generally, as a substance's carbon number increases, its molecular weight increases, and it is, therefore, not a substance of concern via inhalation. The working group also concluded that aromatic hydrocarbons tend to be more toxic than aliphatic hydrocarbons (Reference 11). Table 6 tabulates the inhalation toxicity values used to evaluate exposure to petroleum mixtures. To be consistent with the methodology used in this assessment, the reference concentrations (RfCs) were converted to PRGs using Region 9 exposure assumptions. The resulting PRGs were used as the HBSLs for the petroleum hydrocarbons in this assessment. Appendix D presents these values.

TABLE 6: SUMMARY OF RfCs USED FOR PETROLEUM HYDROCARBONS¹

Carbon Range	Aromatic Inhalation RfC (mg/m ³)	Aliphatic Inhalation RfC (mg/m ³)
C ₅ – C ₆ C _{>6} – C ₈		18.4
C _{>7} – C ₈	0.4	
C _{>8} – C ₁₀ C _{>10} – C ₁₂ C _{>12} – C ₁₆	0.2	1.0
C _{>16} – C ₂₁ C _{>21} – C ₃₅	NA	NA
¹ Reference 11 NA = not applicable for high molecular weight total petroleum hydrocarbons (C _{>16}) because substances in this carbon range are not volatile and therefore, inhalation is not a pathway of concern.		

¹ Aliphatic hydrocarbons are hydrocarbons in which the carbon atoms are joined by single covalent bonds consisting of two shared electrons (e.g., butane). Aromatic hydrocarbons have ring structures (e.g., benzene) (Reference 12).

6.3.2 ACUTE ASSESSMENT

An established method for assessing acute health effects is not currently available. In 1995 the EPA recognized the need for acute exposure guidelines for emergency response purposes and created the National Advisory Committee for Acute Exposure Guideline Levels (AEGLs) for Hazardous Substances. Currently, AEGLs are available for only a few substances.

To overcome the unavailability of acute toxicity data, several state regulatory agencies have suggested that guidelines developed for emergency purposes be used in the interim. Although suggestions have been made to use occupational exposure limits (OELs) by applying additional safety factors (References 13, 14), OELs were not used in this assessment because they introduce even more uncertainty than the use of emergency guidelines. The OELs are designed to protect the workplace environment and assume 8 hours a day, 5 days a week exposures. By definition, these exposures are more chronic than acute. In comparison, emergency planning guidelines are more appropriate because they are typically developed for exposures of 1-hour or less. In addition, safety factors are included as part of the guideline development so that the values are protective of the general population.

For this study, the hierarchy of sources for ATV selection was as follows with each ATV defined below:

- EPA AEGL-1. "AEGL-1 is the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic, nonsensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure."
- AIHA ERPG-1. "The maximum concentration in air below which it is believed nearly all individuals could be exposed for up to 1- hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor."
- DOE TEEL-1. "The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor."

AEGLs were used first when available since they are developed specifically for the purpose of acute exposure assessments. The Emergency Response Planning Guidelines (ERPGs) published by the American Industrial Hygiene Association (AIHA) (Reference 15) were selected next prior to a substance's Temporary Emergency Exposure Limit (TEEL), developed by the U.S. Department of Energy (DOE) (Reference 16). ERPGs were selected before a substance's TEEL because they are vigorously reviewed before they are published, whereas the TEELs are not. Specifically the ERPG-1s and the TEEL-1s were used in this assessment as defined above. Since

TEEL-1s are intended for exposures up to 15-minutes, air concentrations compared to TEELs were averaged over a 15-minute period. Air concentrations compared to ERPGs and AEGLs were averaged over 1-hour, as these values are intended for 1-hour exposures.

Example 7 shows a sample calculation of how a substance's estimated acute concentration was compared to its ATV.

Example 7
Sample Calculation of Comparing a Substance's Estimated Acute Concentration to Its Acute Toxicity Value:

$$\frac{C_{acute(benzene)}}{ATV} = \frac{2.11E+00}{1.56E+05}$$
$$= 1.35E-05 < 1$$

In this example with benzene, the ratio is less than one, indicating that further analysis is not necessary.

7. RISK CHARACTERIZATION

As previously described, the exposure assessment included calculations of time-averaged concentrations for both long-term (chronic) and short-term (acute) exposures. Using a screening approach, a substance's estimated time-averaged air concentration was then compared to chronic HBSLs or ATVs. The comparison was made using the ratio of the HBSL or ATV to the estimated concentration. This approach is conservative because the exposure assumptions used by the EPA and other agencies, to establish HBSLs and ATVs, are likely to overestimate the exposures experienced by offsite residents living near firing ranges.

If this ratio was less than one, no further evaluation was needed. If the chronic or acute averaged concentrations ($C_{chronic}$ or C_{acute}) were greater than the screening levels, resulting in a ratio greater than one, further evaluation would be warranted to determine the potential for health effects. Note that concentrations greater than the screening levels do not indicate an onset of health effects, but rather, the potential for such.

The chronic and acute assessments were conducted as outlined in Section 6.3. Appendix D presents results from the M301A3 risk characterization.

7.1 CHRONIC HEALTH RISK

The outcome of the chronic assessment indicated that no chronic health effects are expected from breathing the air emissions from the M301A3. Since the ratios for all substances were below one at the 100-meter location, further evaluation was not needed.

7.2 ACUTE HEALTH RISK

For the acute assessment, all ratios were below one at the 100-meter location, indicating that no acute health effects are expected from breathing the air emissions from the M301A3. Therefore, further evaluation was not necessary.

7.3 FACT SHEET

Appendix E includes a copy of the fact sheet submitted to the AEC. The fact sheet uses the results from this assessment to communicate information related to inhalation of M301A3 air emissions.

8. UNCERTAINTY DISCUSSION

The limitations inherent in modeling and the added conservatism of the assessment contribute to the uncertainty of the assessment results. The risk assessment methodology typically includes safety factors that are embedded in the toxicity data to ensure adequate protection of the general population, particularly, susceptible individuals such as the sick, elderly, and children. Table 7 identifies areas of uncertainty associated with this assessment.

TABLE 7: TYPES OF UNCERTAINTY

Issue	Uncertainty	Direction of Effect
Modeling		
Modeled versus real-time sampling	The air concentrations in this assessment were modeled. Actual air concentrations taken from the field may be higher or lower.	Varies
Frequency of use for the M301A3	Actual frequency of use for these munitions during training exercises may be different from those stated in this report.	Varies
Hypothetical offsite resident assumed to be located directly downwind	Unless the area around the training facility is populated, the chances that a person living directly downwind is low.	Overestimates
Use of worst-case meteorological conditions	To ensure that this assessment is applicable to most training areas, worst-case meteorological conditions were used in the air model.	Overestimates

TABLE 7: TYPES OF UNCERTAINTY

Issue	Uncertainty	Direction of Effect
Emissions data for the M301A3	The modeled concentrations used in this assessment are based on emissions data collected from the firing of the M301A3 and do not consider potential emissions resulting from the down range functioning of the item.	Underestimates
Exposure Assessment		
Estimating time-averaged concentrations	Actual exposure from the M301A3 is intermittent. If one were to plot a person's exposure profile, the plot would consist of a series of spikes. Since current risk assessment methodology does not allow the evaluation of the potential for health risks as a function of time, a single concentration, averaged over the exposure duration was used. In this assessment, the exposure durations used were 30 years and 1-hour or 15 minutes.	Varies
Comparing estimated concentration to established screening levels	The Region 3 and Region 9 HBSLs were developed using different exposure assumptions than those in this assessment, resulting in more conservative screening levels.	Overestimates
Comparing estimated concentrations to established screening levels	Comparison to screening levels does not account for possible cumulative effects of exposure to more than one substance.	Underestimates
Screening assessment versus calculating an average daily intake	Calculating an average daily intake allows the use of scenario-specific assumptions. However, unless the ratio of concentration to screening level approaches one, a screening assessment is useful as a first-cut evaluation.	Varies
Exposure to substances from other munition items	Other munitions may be used during the same training exercise. These items may contain similar or different substances from those detected in the firing of the M301A3.	Underestimates
Toxicity Assessment		
Lack of toxicity data	Some substances were not quantitatively evaluated because they have no known toxicity data.	Underestimates

TABLE 7: TYPES OF UNCERTAINTY

Issue	Uncertainty	Direction of Effect
Modifying and uncertainty factors for toxicity data	Modifying factors and uncertainty factors of varying degree are typically applied to toxicological values. These factors are used to conservatively account for extrapolating from animal studies for human health evaluation, and to conservatively account for variation in human populations.	Overestimates

9. CONCLUSION

Using conservative assumptions, the assessment indicated that offsite residents who live as close as 100 meters directly downwind from the firing location are safe from breathing air emissions from firing of the M301A3. It is believed that the assumptions contained in this analysis are conservative enough to be protective of all the population including the sick, elderly, and children.

10. RECOMMENDATIONS

The results from this assessment are intended for a hypothetical training facility, and actual results may vary depending on site-specific conditions. This assessment used conservative assumptions (e.g., worst-case meteorological conditions, receptor located directly downwind, etc.) and it is believed that most site-specific analyses would result in even lower concentrations. Therefore, the results from this assessment should be applicable to most training facilities, unless site-specific conditions vary significantly.

11. POINT OF CONTACT

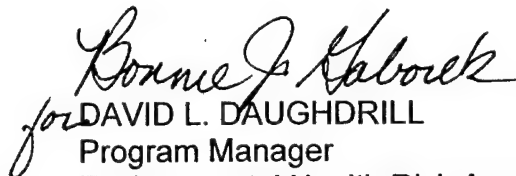
Questions about this report may be directed to Ms. Joleen Mobley at (800) 222-9698 (ext 2953) or (410) 436-2953.

PREPARED BY:



JOLEEN MOBLEY
Environmental Scientist
Environmental Health Risk Assessment
Program

APPROVED BY:


for

DAVID L. DAUGHDRILL
Program Manager
Environmental Health Risk Assessment



STAFFORD D.F.R. COAKLEY
Environmental Engineer
Environmental Health Risk Assessment
Program

APPENDIX A
REFERENCES

1. U.S. Army (1994). *Technical Manual, Army Ammunition Data Sheets Artillery Ammunition Guns, Howitzers, Mortars, Recoilless Rifles, Grenade Launchers, and Artillery Fuzes*. TM-43-0001-28.
2. U.S. Army. Email communication between Mr. Bill Bolt, ATC, and Ms. Joleen Mobley, USACHPPM. Subject: Electronic copy of Firing Point Emission Study Series 4 Emission Factors, 16 April 2001.
3. USACHPPM (Aug 2000). *Ambient Air Quality Consultation NO. 43-EL-1485-00 Air Dispersion Modeling Evaluation For Military Munitions, Aberdeen Proving Ground, MD*.
4. Bowman Environmental, Inc. (1999). *INPUFF2, Multiple Source Integrated Puff Model*, Version 4.1.
5. Title 40, Code of Federal Regulations, Part 68 (40 CFR 68), Chemical Accident Prevention Provisions, 1 July 1998.
6. U.S. Army. Email communication between Ms. Tamera Rush, AEC, and Ms. Joleen Mobley, USACHPPM. Subject: Scenario Information – Small Caliber Ammunition, 3 July 2001.
7. Army Training Evaluation Protocol (ARTEP) 7-20-MTP, *Mission Training Plan for the Infantry Battalion*.
8. EPA. *National Ambient Air Quality Standards*. Available online at <http://www.epa.gov/airprog/airs/criteria.html>
9. EPA (Nov. 2000). *Region 9 Preliminary Remediation Goals (PRG)*. Available online at www.epa.gov/region09/waste/sfund/prg/index.html
10. EPA (April 2001). *Region 3 Risk Based Concentration (RBC) Tables*. Available online at www.epa.gov/reghwmd/risk/riskmenu.htm
11. Total Petroleum Hydrocarbon Criteria Working Group (1997). *Development of Fraction Specific Reference Doses (RfDs) and Reference Concentrations (RfCs) for Total Petroleum Hydrocarbons (TPH)*, Volume 4. Amherst Scientific Publishers. Amherst, MA.
12. Manahan, Stanley (1994). *Environmental Chemistry*. Sixth edition. CRC Press, Inc. Boca Raton, FL.
13. U.S. Army (1996). *Final Screening Risk Assessment for the Anniston Chemical Agent Disposal Facility at the Anniston Army Depot, Alabama*. Revision No. 5. Prepared by the U.S. Army Center for Health Promotion and Preventive Medicine for the Program Manager for Chemical Demilitarization. Aberdeen Proving Ground, Maryland.

14. U.S. Army (1997). *Final Screening Risk Assessment for the Pine Bluff Chemical Agent Disposal Facility at the Pine Bluff Arsenal, Arkansas*. Revision No. 1. Prepared by the U.S. Army Center for Health Promotion and Preventive Medicine for the Program Manager for Chemical Demilitarization. Aberdeen Proving Ground, Maryland.

15. American Industrial Hygiene Association (AIHA) (1999). *Emergency Response Planning Guidelines*. AIHA Press, Fairfax, VA.

16. Department of Energy (1998). *Temporary Emergency Exposure Limits*, Revision 15. <http://www.scapa.bnl.gov>.

APPENDIX B

AIR DISPERSION MODELING OUTPUT DATA

Table B-1: Air Modeling Output Data for the M301A3 81-mm Illuminating Cartridge

Cartridge, 81-mm Illuminating, M301A3									
Substance	Number of items: Trial #1B => 1		Trial #2B => 1		Trial #2B => 1		No. of rounds (l)		1 round
	Net Explosive Weight - N.E.W. per item (lbs.) =>				5.38E-02		release duration (t):		2 seconds
	ATC Firing Test Results ¹						Unit Concentration (UC):		1.636E-04 g/m³/(g/s)
	Trial #1B Measured Actual Concentration (mg/m³)	Trial #2B Measured Actual Concentration (mg/m³)	Daily Measured Background Concentration (mg/m³)	Average Adjusted Emission Factor (EF) (lb./item)	Average Adjusted Emission Factor (lb./lb. NEW)	Total Mass of Substance Emitted (grams/item) M		Substance Concentration (grams/m³) CONC	Substance Emission Rate (g/item)/sec ER ₁
<u>Permanent Gases</u>									
Ammonia (NH ₃)	7.00E+00	7.00E+00	NA	ND	ND	ND	ND	ND	ND
Carbon Dioxide (CO ₂)	4.19E+02	4.66E+02	NA	1.44E-02	2.67E-01	6.517E+00	5.331E-04	5.331E-04	3.259E+00
Carbon Monoxide (CO)	4.38E+02	4.31E+02	NA	1.41E-02	2.62E-01	6.398E+00	5.234E-04	5.234E-04	3.199E+00
Oxides of Nitrogen (NO _x)	7.87E+00	6.52E+00	NA	2.33E-04	4.34E-03	1.059E-01	8.663E-06	8.663E-06	5.295E-02
Sulfur Dioxide (SO ₂)	5.24E-01	5.24E-01	NA	ND	ND	ND	ND	ND	ND
<u>Acid Gases</u>									
Hydrogen Fluoride	2.10E-01	2.20E-01	2.10E-01	ND	ND	ND	ND	ND	ND
Hydrogen Chloride	2.10E-01	2.10E-01	2.00E-01	ND	ND	ND	ND	ND	ND
Hydrogen Bromide	2.10E-01	2.10E-01	2.00E-01	ND	ND	ND	ND	ND	ND
Nitric Acid	2.10E-01	2.10E-01	2.00E-01	ND	ND	ND	ND	ND	ND
Phosphoric Acid	2.10E-01	2.10E-01	2.00E-01	ND	ND	ND	ND	ND	ND
Sulfuric Acid	4.70E-01	7.20E-01	2.00E-01	9.38E-06	1.74E-04	4.254E-03	3.480E-07	3.480E-07	2.127E-03
<u>Cyanide</u>									
Particulate Cyanide	8.40E-02	1.70E-02	1.30E-02	2.92E-06	5.42E-05	1.322E-03	1.082E-07	1.082E-07	6.611E-04
Hydrogen Cyanide	4.60E-02	1.03E-01	2.00E-02	1.94E-06	3.60E-05	8.784E-04	7.185E-08	7.185E-08	4.392E-04
<u>Particulate</u>									
Total Suspended Particulate	2.24E+01	2.79E+01	NA	8.72E-04	1.62E-02	3.957E-01	3.236E-05	3.236E-05	1.978E-01
Particulate Matter <10 microns	2.41E+01	2.93E+01	NA	9.27E-04	1.72E-02	4.203E-01	3.438E-05	3.438E-05	2.101E-01
Particulate Matter <2.5 microns	2.10E+01	2.27E+01	NA	7.58E-04	1.41E-02	3.438E-01	2.812E-05	2.812E-05	1.719E-01
<u>Metals</u>									
Aluminum	1.16E-02	1.07E+00	2.09E-01	1.20E-05	2.22E-04	5.426E-03	4.439E-07	4.439E-07	2.713E-03
Antimony	1.16E-02	1.15E-02	2.09E-01	4.02E-07	7.46E-06	1.822E-04	1.490E-08	1.490E-08	9.110E-05
Arsenic	1.16E-02	1.15E-02	2.09E-01	ND	ND	ND	ND	ND	ND

Table B-1: Air Modeling Output Data for the M301A3 81-mm Illuminating Cartridge

Cartridge, 81-mm Illuminating, M301A3									
Number of items: Trial #1B => 1 Trial #2B => 1				No. of rounds (l)		1 round			
Net Explosive Weight - N.E.W. per item, (lbs.) => 5.38E-02				release duration (t):		2 seconds			
ATC Firing Test Results ¹									
Substance	Trial #1B Measured Actual Concentration (mg/m ³)	Trial #2B Measured Actual Concentration (mg/m ³)	Daily Measured Background Concentration (mg/m ³)	Average Adjusted Emission Factor (EF) (lb./item)	Average Adjusted Emission Factor (lb./lb. NEW)	Total Mass of Substance Emitted (grams/item) M	Substance Concentration (grams/m ³) CONC	Substance Emission Rate (g/item)/sec ER ₁	
Barium	1.16E-02	1.59E-02	2.09E-01	ND	ND	ND	ND	ND	ND
Beryllium	1.16E-02	1.15E-02	2.09E-01	ND	ND	ND	ND	ND	ND
Cadmium	1.16E-02	1.15E-02	2.09E-01	ND	ND	ND	ND	ND	ND
Calcium	1.16E-02	1.49E-01	2.09E-01	ND	ND	ND	ND	ND	ND
Chromium	1.16E-02	1.15E-02	2.09E-01	ND	ND	ND	ND	ND	ND
Cobalt	1.16E-02	1.15E-02	2.09E-01	ND	ND	ND	ND	ND	ND
Copper	1.16E-02	9.54E-01	2.09E-01	9.99E-06	1.86E-04	4.529E-03	3.705E-07	2.265E-03	ND
Lead	1.16E-02	3.32E-02	2.09E-01	7.78E-07	1.45E-05	3.527E-04	2.885E-08	1.764E-04	ND
Magnesium	1.16E-02	3.90E-02	2.09E-01	ND	ND	ND	ND	ND	ND
Manganese	1.16E-02	1.24E-02	2.09E-01	4.30E-07	8.00E-06	1.952E-04	1.597E-08	9.762E-05	ND
Nickel	1.16E-02	2.23E-02	2.09E-01	7.73E-07	1.44E-05	3.508E-04	2.869E-08	1.754E-04	ND
Selenium	1.16E-02	1.15E-02	2.09E-01	ND	ND	ND	ND	ND	ND
Silver	1.16E-02	1.15E-02	2.09E-01	ND	ND	ND	ND	ND	ND
Thallium	1.16E-02	1.15E-02	2.09E-01	ND	ND	ND	ND	ND	ND
Vanadium	1.16E-02	1.15E-02	2.09E-01	ND	ND	ND	ND	ND	ND
Zinc	1.16E-02	2.72E+00	2.09E-01	4.74E-05	8.81E-04	2.151E-02	1.759E-06	1.075E-02	ND
<u>TO-11 Carbonyls</u>									
Formaldehyde	6.10E-01	6.70E-01	2.00E-01	2.22E-05	4.13E-04	1.007E-02	8.241E-07	5.037E-03	ND
Acetaldehyde	3.50E-01	3.50E-01	2.20E-01	5.01E-06	9.31E-05	2.272E-03	1.858E-07	1.136E-03	ND
Acetone	1.00E+00	1.00E+00	1.00E+00	ND	ND	ND	ND	ND	ND
Acrolein	2.00E-01	2.00E-01	2.00E-01	ND	ND	ND	ND	ND	ND
Propionaldehyde	2.00E-01	2.00E-01	2.00E-01	ND	ND	ND	ND	ND	ND
Crotonaldehyde	2.00E-01	2.00E-01	2.00E-01	ND	ND	ND	ND	ND	ND
Butyraldehyde	1.59E+00	1.49E+00	1.54E+00	3.47E-06	6.46E-05	1.576E-03	1.289E-07	7.879E-04	ND
Benzaldehyde	2.00E-01	2.00E-01	2.00E-01	ND	ND	ND	ND	ND	ND
Isovaleraldehyde	2.00E-01	2.00E-01	2.00E-01	ND	ND	ND	ND	ND	ND

Table B-1: Air Modeling Output Data for the M301A3 81-mm Illuminating Cartridge

Substance	Cartridge, 81-mm Illuminating, M301A3					No. of rounds (l)		1 round
	Number of items: Trial #1B =>		1	Trial #2B =>	1	release duration (t):	2 seconds	
	Net Explosive Weight - N.E.W. per item (lbs.) =>					Unit Concentration (UC):	1.636E-04 g/m³/(g/s)	
	ATC Firing Test Results¹					Total Mass of Substance Emitted (grams/item) M	Substance Concentration (grams/m³) CONC	Substance Emission Rate (g/item)/sec ER₁
	Trial #1B Measured Actual Concentration (mg/m³)	Trial #2B Measured Actual Concentration (mg/m³)	Daily Measured Background Concentration (mg/m³)	Average Adjusted Emission Factor (EF) (lb./item)	Average Adjusted Emission Factor (lb./lb. NEW)			
Valeraldehyde	2.00E-01	2.00E-01	2.00E-01	ND	ND	ND	ND	ND
o,m,p-Tolualdehyde	6.00E-01	6.00E-01	6.00E-01	ND	ND	ND	ND	ND
Hexaldehyde	2.00E-01	2.00E-01	2.00E-01	ND	ND	ND	ND	ND
2,5-Dimethylbenzaldehyde	2.00E-01	2.00E-01	2.00E-01	ND	ND	ND	ND	ND
TO-14 VOCs (extended list)								
Propene	9.81E-02	9.64E-02	1.20E-03	3.34E-06	6.20E-05	1.513E-03	1.238E-07	7.565E-04
Dichlorodifluoromethane	2.97E-03	3.46E-03	3.46E-03	ND	ND	ND	ND	ND
Chlorodifluoromethane	3.54E-03	3.54E-03	3.54E-03	ND	ND	ND	ND	ND
Freon 114	6.99E-03	6.99E-03	6.99E-03	ND	ND	ND	ND	ND
Chloromethane	1.24E-03	1.45E-03	1.24E-03	6.38E-09	1.19E-07	2.893E-06	2.367E-10	1.447E-06
Vinyl Chloride	2.56E-03	2.56E-03	2.56E-03	ND	ND	ND	ND	ND
1,3-Butadiene	8.85E-03	1.11E-02	2.21E-03	3.45E-07	6.42E-06	1.567E-04	1.282E-08	7.836E-05
Bromomethane	3.88E-03	3.88E-03	3.88E-03	ND	ND	ND	ND	ND
Chloroethane	2.64E-03	2.64E-03	2.64E-03	ND	ND	ND	ND	ND
Dichlorofluoromethane	4.21E-03	4.21E-03	4.21E-03	ND	ND	ND	ND	ND
Trichlorofluoromethane	1.69E-03	1.69E-03	1.69E-03	3.80E-09	7.07E-08	1.725E-06	1.411E-10	8.623E-07
Pentane	2.07E-03	1.48E-03	5.90E-04	4.23E-08	7.86E-07	1.918E-05	1.569E-09	9.592E-06
Acrolein	8.25E-02	7.34E-02	2.29E-03	2.71E-06	5.03E-05	1.227E-03	1.004E-07	6.136E-04
1,1-Dichlorethene	4.05E-03	4.05E-03	4.05E-03	ND	ND	ND	ND	ND
Freon 113	7.68E-03	7.68E-03	7.68E-03	ND	ND	ND	ND	ND
Acetone	1.43E-02	1.90E-02	7.13E-03	3.46E-07	6.43E-06	1.569E-04	1.283E-08	7.843E-05
Methyl Iodide	5.81E-03	5.81E-03	5.81E-03	ND	ND	ND	ND	ND
Carbon Disulfide	2.80E-03	1.87E-03	3.11E-03	8.10E-08	1.51E-06	3.676E-05	3.007E-09	1.838E-05
Acetonitrile	3.53E-02	4.37E-02	3.36E-03	1.26E-06	2.34E-05	5.717E-04	4.676E-08	2.858E-04
3-Chloropropene	3.13E-03	3.13E-03	3.13E-03	ND	ND	ND	ND	ND
Methylene Chloride	4.17E-02	7.64E-02	1.39E-02	1.60E-06	2.97E-05	7.251E-04	5.931E-08	3.625E-04
tert-Butyl Alcohol	3.03E-03	3.03E-03	3.03E-03	ND	ND	ND	ND	ND
Acrylonitrile	1.52E-02	2.17E-02	2.17E-03	6.40E-07	1.19E-05	2.904E-04	2.375E-08	1.452E-04
trans-1,2-Dichloroethene	3.96E-03	3.96E-03	3.96E-03	ND	ND	ND	ND	ND

Table B-1: Air Modeling Output Data for the M301A3 81-mm Illuminating Cartridge

Cartridge, 81-mm Illuminating, M301A3									
Substance	Number of items: Trial #1B => 1		Trial #2B =>		1		No. of rounds (l)		
	Net Explosive Weight - N.E.W. per item (lbs.) =>		Average Adjusted Emission Factor (EF) (lb./item)		5.38E-02		release duration (t):		
			ATC-Firing Test Results ¹		Unit Concentration (UC):			1.636E-04 g/m³/(g/s)	
	Trial #1B Measured Actual Concentration (mg/m³)	Trial #2B Measured Actual Concentration (mg/m³)	Daily Measured Background Concentration (mg/m³)	Average Adjusted Emission Factor (EF) (lb./item)	Average Adjusted Emission Factor (lb./lb. NEW)	Total Mass of Substance Emitted (grams/item)	Substance Concentration (grams/m³) CONC	Substance Emission Rate (g/item)/sec ER ₁	1 round
Methyl t-Butyl Ether	2.52E-03	1.80E-03	1.08E-03	4.00E-08	7.43E-07	1.813E-05	1.483E-09	9.066E-06	2 seconds
Hexane	9.52E-02	1.76E-02	1.76E-02	1.39E-06	2.57E-05	6.284E-04	5.140E-08	3.142E-04	
1,1-Dichloroethane	3.97E-03	3.97E-03	3.97E-03	ND	ND	ND	ND	ND	
Vinyl Acetate	3.52E-03	3.52E-03	3.52E-03	ND	ND	ND	ND	ND	
cis-1,2-Dichloroethene	3.96E-03	3.96E-03	3.96E-03	ND	ND	ND	ND	ND	
2-Butanone	1.77E-03	2.95E-03	2.95E-03	8.19E-08	1.52E-06	3.714E-05	3.038E-09	1.857E-05	
Ethyl Acetate	3.60E-03	3.60E-03	3.60E-03	ND	ND	ND	ND	ND	
Methyl Acrylate	3.52E-03	3.52E-03	3.52E-03	ND	ND	ND	ND	ND	
Chloroform	4.88E-03	4.88E-03	4.88E-03	ND	ND	ND	ND	ND	
1,1,1-Trichloroethane	1.09E-02	5.46E-03	3.27E-03	1.78E-07	3.30E-06	8.065E-05	6.597E-09	4.033E-05	
Carbon Tetrachloride	6.29E-03	6.29E-03	6.29E-03	ND	ND	ND	ND	ND	
1,2-Dichloroethane	1.62E-02	2.02E-02	4.05E-03	6.32E-07	1.17E-05	2.867E-04	2.345E-08	1.434E-04	
Benzene	1.12E+00	1.25E+00	3.20E-03	4.09E-05	7.61E-04	1.856E-02	1.518E-06	9.281E-03	
Isocetane	4.67E-03	4.67E-03	4.67E-03	ND	ND	ND	ND	ND	
Heptane	1.23E-03	4.10E-03	4.10E-03	4.27E-08	7.93E-07	1.935E-05	1.583E-09	9.677E-06	
Trichloroethane	4.88E-03	4.88E-03	4.88E-03	ND	ND	ND	ND	ND	
Ethyl Acrylate	4.09E-03	4.09E-03	4.09E-03	ND	ND	ND	ND	ND	
1,2-Dichloropropane	4.62E-03	4.62E-03	4.62E-03	ND	ND	ND	ND	ND	
Methyl Methacrylate	4.09E-03	1.64E-03	4.09E-03	5.68E-08	1.06E-06	2.578E-05	2.109E-09	1.289E-05	
Dibromomethane	7.11E-03	7.11E-03	7.11E-03	ND	ND	ND	ND	ND	
1,4-Dioxane	3.60E-03	3.60E-03	3.60E-03	ND	ND	ND	ND	ND	
Bromodichloromethane	6.70E-03	6.70E-03	6.70E-03	ND	ND	ND	ND	ND	
cis-1,3-Dichloropropene	4.54E-03	4.54E-03	4.54E-03	ND	ND	ND	ND	ND	
4-Methyl-2-Pentanone	4.10E-03	4.10E-03	4.10E-03	ND	ND	ND	ND	ND	
Toluene	8.29E-02	8.29E-02	1.51E-03	2.83E-06	5.26E-05	1.283E-03	1.050E-07	6.415E-04	
Octane	4.67E-03	4.67E-03	4.67E-03	ND	ND	ND	ND	ND	
trans-1,3-Dichloropropene	4.54E-03	4.54E-03	4.54E-03	ND	ND	ND	ND	ND	
Ethyl Methacrylate	4.67E-03	4.67E-03	4.67E-03	ND	ND	ND	ND	ND	
1,1,2-Trichloroethane	5.46E-03	5.46E-03	5.46E-03	ND	ND	ND	ND	ND	

Table B-1: Air Modeling Output Data for the M301A3 81-mm Illuminating Cartridge

Cartridge, 81-mm Illuminating, M301A3									
Substance	Number of items: Trial #1B =>		Trial #2B =>		1		No. of rounds (l)		
	Net Explosive Weight - N.E.W. per item (lbs.) =>				5.38E-02		release duration (t):		
							Unit Concentration (UC):		
							1.636E-04 g/m³/(g/s)		
ATC Firing Test Results ¹									
	Trial #1B Measured Actual Concentration (mg/m³)	Trial #2B Measured Actual Concentration (mg/m³)	Daily Measured Background Concentration (mg/m³)	Average Adjusted Emission Factor (EF) (lb./item)	Average Adjusted Emission Factor (lb./lb. NEW)	Total Mass of Substance Emitted (grams/item) M	Substance Concentration (grams/m³) CONC	Substance Emission Rate (g/item)/sec ER ₁	
Tetrachloroethene	6.78E-03	6.78E-03	6.78E-03	ND	ND	ND	ND	ND	ND
2-Hexanone	4.10E-03	4.10E-03	4.10E-03	ND	ND	ND	ND	ND	ND
Dibromochloromethane	8.52E-03	8.52E-03	8.52E-03	ND	ND	ND	ND	ND	ND
1,2-Dibromoethane	7.68E-03	7.68E-03	7.68E-03	ND	ND	ND	ND	ND	ND
Chlorobenzene	4.60E-03	4.60E-03	4.60E-03	ND	ND	ND	ND	ND	ND
1,1,1,2-Tetrachloroethane	6.87E-03	6.87E-03	6.87E-03	ND	ND	ND	ND	ND	ND
Ethylbenzene	8.68E-03	8.68E-03	2.17E-03	2.31E-07	4.29E-06	1.048E-04	8.569E-09	5.238E-05	5.238E-05
m/p-Xylene	1.30E-02	1.74E-02	8.68E-03	2.46E-07	4.56E-06	1.114E-04	9.114E-09	5.571E-05	5.571E-05
o-Xylene	1.30E-02	1.74E-02	8.68E-03	2.46E-07	4.56E-06	1.114E-04	9.114E-09	5.571E-05	5.571E-05
Styrene	2.04E-01	1.83E-01	1.28E-03	6.69E-06	1.24E-04	3.032E-03	2.481E-07	1.516E-03	1.516E-03
Bromoform	1.03E-02	1.03E-02	1.03E-02	ND	ND	ND	ND	ND	ND
Cumene	4.92E-03	1.47E-03	4.92E-03	5.12E-08	9.51E-07	2.321E-05	1.899E-09	1.161E-05	1.161E-05
1,1,2,2-Tetrachloroethane	6.87E-03	6.87E-03	6.87E-03	ND	ND	ND	ND	ND	ND
1,2,3-Trichloropropane	6.03E-03	6.03E-03	6.03E-03	ND	ND	ND	ND	ND	ND
Bromobenzene	6.42E-03	6.42E-03	6.42E-03	ND	ND	ND	ND	ND	ND
4-Ethyltoluene	9.83E-04	2.46E-03	4.92E-03	5.97E-08	1.11E-06	2.708E-05	2.215E-09	1.354E-05	1.354E-05
1,3,5-Trimethylbenzene	9.83E-04	1.97E-03	4.92E-03	5.12E-08	9.51E-07	2.322E-05	1.899E-09	1.161E-05	1.161E-05
Alpha Methyl Styrene	1.45E-03	4.83E-03	4.83E-03	5.03E-08	9.35E-07	2.283E-05	1.867E-09	1.141E-05	1.141E-05
1,2,4-Trimethylbenzene	4.92E-03	4.92E-03	2.46E-03	9.09E-08	1.69E-06	4.121E-05	3.371E-09	2.060E-05	2.060E-05
1,3-Dichlorobenzene	6.01E-03	6.01E-03	6.01E-03	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	6.01E-03	6.01E-03	6.01E-03	ND	ND	ND	ND	ND	ND
Benzyl Chloride	5.18E-03	5.18E-03	5.18E-03	ND	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	6.01E-03	6.01E-03	6.01E-03	ND	ND	ND	ND	ND	ND
Hexachloroethane	9.68E-03	9.68E-03	9.68E-03	ND	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	7.42E-03	7.42E-03	7.42E-03	ND	ND	ND	ND	ND	ND
Hexachlorobutadiene	1.07E-02	1.07E-02	1.07E-02	ND	ND	ND	ND	ND	ND
Hydrocarbons									
Methane	2.76E+00	2.49E+00	1.42E+00	4.48E-05	8.32E-04	2.030E-02	1.661E-06	1.015E-02	1.015E-02
Ethylene	7.14E-01	6.91E-01	2.87E-02	2.44E-05	4.53E-04	1.105E-02	9.041E-07	5.526E-03	5.526E-03

Table B-1: Air Modeling Output Data for the M301A3 81-mm Illuminating Cartridge

Substance	Cartridge, 81-mm Illuminating, M301A3				No. of rounds (l)		1 round	
	Number of items: Trial #1B =>		Trial #2B =>		release duration (t):		2 seconds	
	1		Trial #2B =>		Unit Concentration (UC):		1.636E-04	
	Net Explosive Weight - N.E.W. per item (lbs.) =>		5.38E-02		Substance Concentration (grams/m³) CONC		Substance Emission Rate (g/item)/sec ER₁	
	5.38E-02		5.38E-02		Total Mass of Substance Emitted (grams/item) M		4.208E-03	
ATC Firing Test Results¹								
	Trial #1B Measured Actual Concentration (mg/m³)	Trial #2B Measured Actual Concentration (mg/m³)	Daily Measured Background Concentration (mg/m³)	Average Adjusted Emission Factor (EF) (lb./item)	Average Adjusted Emission Factor (lb./lb. NEW)			
Acetylene	6.60E-01	4.09E-01	2.66E-02	1.86E-05	3.45E-04	8.416E-03	6.884E-07	4.208E-03
Ethane	2.95E-02	3.07E-02	3.07E-02	ND	ND	ND	ND	ND
Propylene	1.10E-01	9.81E-02	4.30E-02	3.61E-06	6.72E-05	1.639E-03	1.341E-07	8.195E-04
Propane	4.33E-02	4.51E-02	4.51E-02	ND	ND	ND	ND	ND
Propyne	4.16E-02	4.00E-02	4.00E-02	1.44E-06	2.68E-05	6.545E-04	5.354E-08	3.273E-04
Isobutane	5.47E-02	5.94E-02	5.94E-02	ND	ND	ND	ND	ND
1-Butene/Isobutylene	1.08E-01	1.08E-01	1.08E-01	ND	ND	ND	ND	ND
1,3-Butadiene/butane	1.65E-01	1.65E-01	1.65E-01	ND	ND	ND	ND	ND
cis-butene	5.51E-02	5.74E-02	5.74E-02	ND	ND	ND	ND	ND
1-Butyne/trans-butene	1.06E-01	1.06E-01	1.06E-01	ND	ND	ND	ND	ND
2-Butyne	5.31E-02	5.53E-02	5.53E-02	ND	ND	ND	ND	ND
n-Pentane	7.08E-02	7.38E-02	7.38E-02	ND	ND	ND	ND	ND
n-Hexane	7.75E-02	8.81E-02	8.81E-02	ND	ND	ND	ND	ND
SVOCs (8270 List)								
N-nitrosodimethylamine	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND
Bis(2-chloroethyl)ether	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND
Phenol	1.78E-02	1.00E-02	1.83E-02	3.48E-07	6.46E-06	1.577E-04	1.290E-08	7.887E-05
2-chlorophenol	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND
1,3-dichlorobenzene	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND
1,4-dichlorobenzene	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND
1,2-dichlorobenzene	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND
Benzyl alcohol	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND
Bis(2-chloroisopropyl)ether	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND
2-methylphenol	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND
Hexachloroethane	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND
N-nitroso-di-n-propylamine	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND
4-methylphenol	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND
Nitrobenzene	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND
Isophorone	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND

Table B-1: Air Modeling Output Data for the M301A3 81-mm Illuminating Cartridge

Substance	Cartridge, 81-mm Illuminating, M301A3						No. of rounds (l)		1 round	
	Number of items: Trial #1B =>			Trial #2B =>			release duration (t):		2 seconds	
	1			Trial #2B =>			1			
	Net Explosive Weight - N.E.W. per item (lbs.) =>						Unit Concentration (UC):		1.636E-04 g/m³/(g/s)	
	ATC Firing Test Results¹						Total Mass of Substance Emitted (grams/item) M		Substance Concentration (grams/m³) CONC	
	Trial #1B Measured Actual Concentration (mg/m³)	Trial #2B Measured Actual Concentration (mg/m³)	Daily Measured Background Concentration (mg/m³)	Average Adjusted Emission Factor (EF) (lb./item)	Average Adjusted Emission Factor (lb./lb. NEW)					Substance Emission Rate (g/item)/sec ER₁
2-nitrophenol	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND	ND
2,4-dimethylphenol	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND	ND
Bis(2-chloroethoxy)methane	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND	ND
2,4-dichlorophenol	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND	ND
1,2,4-trichlorobenzene	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND	ND
Naphthalene	3.73E-02	3.16E-02	1.83E-02	1.20E-06	2.22E-05	5.426E-04	4.438E-08	2.713E-04		
4-chloroaniline	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND	ND
Hexachlorobutadiene	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND	ND
4-chloro-3-methylphenol	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND	ND
2-methylnaphthalene	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND	ND
Hexachlorocyclopentadiene	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND	ND
2,4,6-trichlorophenol	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND	ND
2,4,5-trichlorophenol	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND	ND
2-chloronaphthalene	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND	ND
2-nitroaniline	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND	ND
Dimethylphthalate	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND	ND
2,6-dinitrotoluene	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND	ND
Acenaphthene	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND	ND
3-nitroaniline	3.55E-02	3.52E-02	3.66E-02	ND	ND	ND	ND	ND	ND	ND
2,4-dinitrophenol	3.55E-02	3.52E-02	3.66E-02	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND	ND
2,4-dinitrotoluene	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND	ND
4-nitrophenol	3.55E-02	3.52E-02	3.66E-02	ND	ND	ND	ND	ND	ND	ND
Fluorene	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND	ND
4-chlorophenyl-phenylether	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND	ND
Diethylphthalate	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND	ND
4-nitroaniline	3.55E-02	3.52E-02	3.66E-02	ND	ND	ND	ND	ND	ND	ND
4,6-dinitro-2-methylphenol	3.55E-02	3.52E-02	3.66E-02	ND	ND	ND	ND	ND	ND	ND

Table B-1: Air Modeling Output Data for the M301A3 81-mm Illuminating Cartridge

Cartridge, 81-mm Illuminating, M301A3									
Substance	Number of items: Trial #1B => 1		Trial #2B =>		1		No. of rounds (I)		
	Net Explosive Weight - N.E.W. per item (lbs.) =>				release duration (t):			2 seconds	
					Unit Concentration (UC):			1.636E-04 g/m³/(g/s)	
ATC Firing Test Results¹									
	Trial #1B Measured Actual Concentration (mg/m³)	Trial #2B Measured Actual Concentration (mg/m³)	Daily Measured Background Concentration (mg/m³)	Average Adjusted Emission Factor (EF) (lb./item)	Average Adjusted Emission Factor (lb./lb. NEW)	Total Mass of Substance Emitted (grams/item) M	Substance Concentration (grams/m³) CONC	Substance Emission Rate (g/item)/sec ER _i	
n-Nitrosodiphenylamine(1)	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND
4-bromophenyl-phenylether	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND
Hexachlorobenzene	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND
Pentachlorophenol	3.55E-02	3.52E-02	3.66E-02	ND	ND	ND	ND	ND	ND
Phenanthrene	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND
Anthracene	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND
Di-n-butylphthalate	1.37E-02	1.76E-02	1.83E-02	4.74E-07	8.82E-06	2.152E-04	1.760E-08	1.076E-04	
Fluoranthene	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND
Pyrene	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND
Butylbenzylphthalate	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND
Chrysene	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND
Bis(2-ethylhexyl)phthalate	1.24E-01	8.61E-02	9.88E-02	4.46E-07	8.30E-06	2.025E-04	1.656E-08	1.012E-04	
Di-n-octylphthalate	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND
Benzo(g,h,i)perylene	1.78E-02	1.76E-02	1.83E-02	ND	ND	ND	ND	ND	ND
TO-13 PAHs									
Naphthalene	2.66E-02	2.64E-02	2.01E-04	1.37E-06	2.55E-05	6.224E-04	5.091E-08	3.112E-04	
Acenaphthylene	3.37E-03	3.69E-03	1.83E-05	1.81E-07	3.37E-06	8.216E-05	6.721E-09	4.108E-05	
Acenaphthene	1.17E-04	1.49E-04	2.01E-05	5.68E-09	1.06E-07	2.577E-06	2.108E-10	1.288E-06	
Fluorene	7.81E-04	8.26E-04	2.74E-05	4.01E-08	7.45E-07	1.820E-05	1.488E-09	9.098E-06	
Phenanthrene	9.06E-04	8.97E-04	9.33E-05	4.24E-08	7.89E-07	1.925E-05	1.575E-09	9.626E-06	
Anthracene	1.42E-04	1.34E-04	1.83E-05	7.25E-09	1.35E-07	3.288E-06	2.689E-10	1.644E-06	
Fluoranthene	2.66E-04	2.11E-04	3.48E-05	1.12E-08	2.08E-07	5.086E-06	4.160E-10	2.543E-06	
Pyrene	1.78E-04	1.39E-04	2.56E-05	7.33E-09	1.36E-07	3.323E-06	2.718E-10	1.661E-06	

Table B-1: Air Modeling Output Data for the M301A3 81-mm Illuminating Cartridge

Cartridge, 81-mm Illuminating, M301A3									
Substance	Number of items: Trial #1B =>		1	Trial #2B =>		1	No. of rounds (l)		1 round
	Net Explosive Weight - N.E.W. per item (lbs.) =>		5.38E-02				release duration (t):	2 seconds	
							Unit Concentration (UC):	1.636E-04 g/m³/(g/s)	
ATC-Firing Test Results ¹									
	Trial #1B Measured Actual Concentration (mg/m³)	Trial #2B Measured Actual Concentration (mg/m³)	Daily Measured Background Concentration (mg/m³)	Average Adjusted Emission Factor (EF) (lb./item)	Average Adjusted Emission Factor (lb./lb. NEW)	Total Mass of Substance Emitted (grams/item) M	Substance Concentration (grams/m³) CONC	Substance Emission Rate (g/item)/sec ER ₁	
Benzo(a)anthracene	1.42E-04	7.03E-05	1.83E-05	6.15E-09	1.14E-07	2.790E-06	2.282E-10	1.395E-06	
Chrysene	3.55E-04	1.76E-04	1.83E-05	1.54E-08	2.86E-07	6.974E-06	5.705E-10	3.487E-06	
Benzo(b)fluoranthene	3.37E-04	2.29E-04	1.83E-05	1.57E-08	2.91E-07	7.109E-06	5.816E-10	3.555E-06	
Benzo(k)fluoranthene	2.13E-04	1.34E-04	1.83E-05	9.71E-09	1.81E-07	4.406E-06	3.604E-10	2.203E-06	
Benzo(e)pyrene	2.49E-04	1.69E-04	1.83E-05	1.16E-08	2.15E-07	5.241E-06	4.288E-10	2.621E-06	
Benzo(a)pyrene	1.42E-04	1.05E-04	1.83E-05	6.76E-09	1.26E-07	3.066E-06	2.508E-10	1.533E-06	
Indeno(1,2,3-cd)pyrene	2.13E-04	1.71E-04	1.83E-05	1.04E-08	1.92E-07	4.696E-06	3.842E-10	2.348E-06	
Dibenz(a,h)anthracene	3.37E-05	3.87E-05	1.83E-05	1.84E-09	3.42E-08	8.355E-07	6.834E-11	4.177E-07	
Benzo(g,h,i)perylene	2.31E-04	2.11E-04	1.83E-05	1.17E-08	2.17E-07	5.294E-06	4.331E-10	2.647E-06	
<u>Dioxins and Furans</u>									
2378-TCDD	1.37E-09	1.16E-09	1.58E-09	ND	ND	ND	ND	ND	
12378-PECDD	1.75E-09	1.51E-09	1.97E-09	ND	ND	ND	ND	ND	
123478-HXCDD	8.82E-10	7.43E-10	1.09E-09	ND	ND	ND	ND	ND	
123678-HXCDD	1.01E-09	8.50E-10	1.15E-09	ND	ND	ND	ND	ND	
123789-HXCDD	1.60E-09	1.31E-09	1.90E-09	ND	ND	ND	ND	ND	
1234678-HPCDD	1.46E-08	1.63E-08	3.43E-09	4.24E-13	7.88E-12	1.923E-10	1.573E-14	9.617E-11	
OCDD	9.42E-08	1.11E-07	3.80E-08	2.33E-12	4.33E-11	1.058E-09	8.653E-14	5.289E-10	
2378-TCDF	1.32E-09	1.16E-09	1.22E-09	ND	ND	ND	ND	ND	
12378-PECDF	1.42E-09	1.18E-09	1.66E-09	ND	ND	ND	ND	ND	
23478-PECDF	2.72E-09	2.15E-09	2.73E-09	ND	ND	ND	ND	ND	
123478-HXCDF	1.23E-09	1.03E-09	1.44E-09	ND	ND	ND	ND	ND	
123678-HXCDF	1.35E-09	1.07E-09	1.53E-09	ND	ND	ND	ND	ND	
123789-HXCDF	9.25E-10	7.80E-10	1.03E-09	ND	ND	ND	ND	ND	
234678-HXCDF	4.75E-10	4.10E-10	5.39E-10	ND	ND	ND	ND	ND	
1234678-HPCDF	2.23E-09	2.45E-09	1.44E-09	3.45E-14	6.41E-13	1.564E-11	1.279E-15	7.820E-12	
1234789-HPCDF	1.03E-09	1.07E-09	1.35E-09	ND	ND	ND	ND	ND	
OCDF	3.83E-09	4.72E-09	2.93E-09	5.33E-14	9.90E-13	2.417E-11	1.977E-15	1.209E-11	
<u>Energetics</u>									

Table B-1: Air Modeling Output Data for the M301A3 81-mm Illuminating Cartridge

Cartridge, 81-mm Illuminating, M301A3						No. of rounds (l)		1 round
Number of items: Trial #1B => 1			Trial #2B =>			1		2 seconds
Net Explosive Weight - N.E.W. per item (lbs.) =>						5.38E-02		1.636E-04 g/m³/(g/s)
Substance	ATC Firing Test Results¹					Total Mass of Substance Emitted (grams/item) M	Substance Concentration (grams/m³) CONC	Substance Emission Rate (g/item)/sec ER₁
	Trial #1B Measured Actual Concentration (mg/m³)	Trial #2B Measured Actual Concentration (mg/m³)	Daily Measured Background Concentration (mg/m³)	Average Adjusted Emission Factor (EF) (lb./item)	Average Adjusted Emission Factor (lb./lb. NEW)			
Nitrobenzene	3.47E-03	3.42E-03	NA	ND	ND	ND	ND	ND
2-Nitrotoluene	3.47E-03	3.42E-03	NA	ND	ND	ND	ND	ND
3-Nitrotoluene	3.47E-03	3.42E-03	NA	ND	ND	ND	ND	ND
4-Nitrotoluene	3.47E-03	3.42E-03	NA	ND	ND	ND	ND	ND
Nitroglycerine	1.46E-02	2.39E-02	NA	6.68E-07	1.24E-05	3.030E-04	2.479E-08	1.515E-04
1,3-Dinitrobenzene	3.47E-03	3.42E-03	NA	ND	ND	ND	ND	ND
2,6-Dinitrotoluene	3.47E-03	3.42E-03	NA	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	3.47E-03	3.42E-03	NA	ND	ND	ND	ND	ND
1,3,5-Trinitrobenzene	3.47E-03	3.42E-03	NA	ND	ND	ND	ND	ND
2,4,6-Trinitrotoluene	3.47E-03	3.42E-03	NA	ND	ND	ND	ND	ND
RDX	3.47E-03	3.42E-03	NA	ND	ND	ND	ND	ND
4-Amino-2,6-Dinitrotoluene	3.47E-03	3.42E-03	NA	ND	ND	ND	ND	ND
2-Amino-4,6-Dinitrotoluene	3.47E-03	3.42E-03	NA	ND	ND	ND	ND	ND
Tetryl	3.47E-03	3.42E-03	NA	ND	ND	ND	ND	ND
HMX	6.94E-03	6.84E-03	NA	ND	ND	ND	ND	ND
Pentaerythritoltetranitrate	6.94E-03	6.84E-03	NA	ND	ND	ND	ND	ND
Dibutyl phthalate	8.67E-02	8.55E-02	NA	ND	ND	ND	ND	ND
Diocetyl phthalate	8.67E-02	8.55E-02	NA	ND	ND	ND	ND	ND
Diphenylamine	8.67E-02	8.55E-02	NA	ND	ND	ND	ND	ND

Footnotes:

¹ATC = Aberdeen Test Center (for additional information on the data, refer to the Firing Point Emission Study)

NA = Not Applicable

ND = Not Detected

Footnotes:

¹ATC = Aberdeen Test Center (for additional information on the data, refer to the Firing Point Emission Study)

NA = Not Applicable

ND = Not Detected

APPENDIX C

HEALTH-BASED SCREENING LEVELS AND ACUTE TOXICITY VALUES

Appendix C: Health-Based Screening Levels and Acute Toxicity Values

Substance	CAS#	PRG	Toxicity Endpoint	RBC	Toxicity Endpoint	NAAQS	HBSL Toxicity Endpoint	ERPG	TEEL	AEGL	ATV	ATV Source
1,1,1,2-Tetrachloroethane	630-20-6	2.60E-01	c	2.41E-01	c		2.41E-01	c	6.00E+04		6.00E+04	T
1,1,1-Trichloroethane	71-55-6	1.04E+03	nc	2.30E+03	nc		1.04E+03	nc	1.94E+06	1.25E+06	1.25E+06	A
1,1,2,2-Tetrachloroethane	79-34-5	3.31E-02	c	3.13E-02	c		3.13E-02	c	2.00E+04		2.00E+04	T
1,1,2-Trichloroethane	79-00-5	1.20E-01	c	1.12E-01	c		1.12E-01	c	5.00E+04		5.00E+04	T
1,1-Dichloroethane	75-34-3	5.21E+02	nc	5.11E+02	nc		5.11E+02	nc	1.25E+06		1.25E+06	T
1,1-Dichloroethene	75-35-4		nc	3.58E-02	c		3.58E-02	c	7.50E+04		7.50E+04	T
1,2,3-Trichloropropane	96-18-4	9.61E-04	c	3.13E-03	c		9.61E-04	c	6.00E+04		6.00E+04	T
1,2,4-Trichlorobenzene	120-82-1	2.08E+02	nc	2.08E+02	nc		2.08E+02	nc	3.50E+04		3.50E+04	T
1,2,4-Trimethylbenzene	95-63-6	6.21E+00	nc	6.21E+00	nc		6.21E+00	nc	1.80E+05		1.80E+05	T
1,2-Dibromoethane	106-93-4	8.73E-03	c	8.24E-03	c		8.24E-03	c	1.50E+05		1.50E+05	T
1,2-Dichlorobenzene	95-50-1	2.09E+02	nc	3.29E+02	nc		2.09E+02	nc	3.00E+05		3.00E+05	T
1,2-Dichloroethane	107-06-2	7.39E-02	c	6.88E-02	c		6.88E-02	c	7.50E+03		7.50E+03	T
1,2-Dichloropropane	78-87-5	9.89E-02	c	9.21E-02	c		9.21E-02	c	5.00E+05		5.00E+05	T
1,3,5-Trimethylbenzene	108-67-8	6.21E+00	nc	6.21E+00	nc		6.21E+00	nc	1.25E+05		1.25E+05	T
1,3,5-Trinitrobenzene	99-35-4	1.10E+02	nc	1.10E+02	nc		1.10E+02	nc	3.00E+04		3.00E+04	T
1,3-Butadiene	106-99-0	3.74E-03	c	3.48E-03	c		3.48E-03	c	2.20E+04		2.20E+04	E
1,3-Dichlorobenzene	541-73-1	3.29E+00	nc	1.10E+02	nc		3.29E+00	nc	4.00E+04		4.00E+04	T

Substance	CAS#	PRG	Toxicity Endpoint	RBC	Toxicity Endpoint	NAAQS	HBSL	Toxicity Endpoint	ERPG	TEEL	AEGL	ATV	ATV Source
1,3-Dinitrobenzene	99-65-0	3.65E-01	nc	3.65E-01	nc		3.65E-01	nc		3.00E+03		3.00E+03	T
1,4-Dichlorobenzene	106-46-7	3.06E-01	c	2.85E-01	c		2.85E-01	c		6.00E+05		6.00E+05	T
1,4-Dioxane	123-91-1	6.11E-01	c	5.69E-01	c		5.69E-01	c		7.50E+04		7.50E+04	T
1234678-HPCDD	35822-46-9									6.00E+02		6.00E+02	T
1234678-HPCDF	67562-39-4									1.50E+02		1.50E+02	T
1234789-HPCDF	55673-89-7									2.50E+02		2.50E+02	T
123478-HXCDD	39227-28-6									1.25E+00		1.25E+00	T
123478-HXCDF	70648-26-9									7.50E+00		7.50E+00	T
123678-HXCDD	57653-85-7									1.50E+01		1.50E+01	T
123678-HXCDF	57117-44-9									2.50E+00		2.50E+00	T
123789-HXCDD	19408-74-3	1.48E-06	c	1.38E-06	c		1.38E-06	c		1.50E+01		1.50E+01	T
123789-HXCDF	72918-21-9									1.25E+02		1.25E+02	T
12378-PECDD	40321-76-4									2.50E+00		2.50E+00	T
12378-PECDF	57117-41-6									7.50E+00		7.50E+00	T
1-Butene/Isobutylene	106-98-9									7.50E+06		7.50E+06	T
2,4,5-trichlorophenol	95-95-4	3.65E+02	nc	3.65E+02	nc		3.65E+02	nc		3.00E+04		3.00E+04	T
2,4,6-trichlorophenol	88-06-2	6.20E-01	c	6.26E-01	c		6.20E-01	c		3.00E+04		3.00E+04	T
2,4,6-Trinitrotoluene	118-96-7	2.24E-01	c	2.09E-01	c		2.09E-01	c		1.50E+03		1.50E+03	T
2,4-dichlorophenol	120-83-2	1.10E+01	nc	1.10E+01	nc		1.10E+01	nc		3.00E+04		3.00E+04	T

Substance	CAS#	PRG	Toxicity Endpoint	RBC	Toxicity Endpoint	NAAQS	HBSL Toxicity Endpoint	ERPG	TEEL	AEGL	ATV	ATV Source
2,4-dimethylphenol	105-67-9	7.30E+01	nc	7.30E+01	nc		7.30E+01	nc				
2,4-dinitrophenol	51-28-5	7.30E+00	nc	7.30E+00	nc		7.30E+00	nc	7.50E+03		7.50E+03	T
2,4-Dinitrotoluene	121-14-2	7.30E+00	nc	7.30E+00	nc		7.30E+00	nc	6.00E+02		6.00E+02	T
2,5-Dimethylbenzaldehyde 5779-94-2												
2,6-dinitrotoluene	606-20-2	3.65E+00	nc	3.65E+00	nc		3.65E+00	nc	6.00E+02		6.00E+02	T
234678-HXCDF	60851-34-5								1.50E+00		1.50E+00	T
23478-PECDF	57117-31-4								7.50E-02		7.50E-02	T
2378-TCDD	1746-01-6	4.48E-08	c	4.17E-08	c		4.17E-08	c	3.50E+00		3.50E+00	T
2378-TCDF	51207-31-9								2.00E+00		2.00E+00	T
2-Amino-4,6-Dinitrotoluene 35572-78-2									1.50E+04		1.50E+04	T
2-Butanone	78-93-3	1.04E+03	nc	1.04E+03	nc		1.04E+03	nc	7.50E+05		7.50E+05	T
2-Butyne	503-17-3											
2-chloronaphthalene	91-58-7	2.92E+02	nc	2.92E+02	nc		2.92E+02	nc	6.00E+02		6.00E+02	T
2-chlorophenol	95-57-8	1.83E+01	nc	1.83E+01	nc		1.83E+01	nc	6.00E+03		6.00E+03	T
2-Hexanone	591-78-6			5.11E+00	nc		5.11E+00	nc	4.00E+04		4.00E+04	T
2-methylnaphthalene	91-57-6			7.30E+01	nc		7.30E+01	nc	2.00E+04		2.00E+04	T
2-methylphenol	95-48-7	1.83E+02	nc	1.83E+02	nc		1.83E+02	nc	2.00E+04		2.00E+04	T
2-nitroaniline	88-74-4	2.09E-01	nc	2.08E-01	nc		2.08E-01	nc				
2-nitrophenol	88-75-5								4.00E+03		4.00E+03	T

Substance	CAS#	PRG	Toxicity Endpoint	RBC	Toxicity Endpoint	NAAQS	HBSL	Toxicity Endpoint	ERPG	TEEL	AEGL	ATV	ATV Source
2-Nitrotoluene	88-72-2	3.65E+01	nc	3.65E+01	nc		3.65E+01	nc					
3-Chloropropene	107-05-1	1.04E+00	nc						9.39E+03	7.50E+03		9.39E+03	E
3-nitroaniline	99-09-2												
3-Nitrotoluene	99-08-1	3.65E+01	nc	7.30E+01	nc		3.65E+01	nc					
4,6-dinitro-2-methylphenol	534-52-1			3.65E-01	nc		3.65E-01	nc		2.00E+02		2.00E+02	T
4-Amino-2,6-Dinitrotoluene	19406-51-0												
4-bromophenyl-phenylethe	101-55-3												
4-chloro-3-methylphenol	59-50-7									2.00E+04		2.00E+04	T
4-chloroaniline	106-47-8	1.46E+01	nc	1.46E+01	nc		1.46E+01	nc		3.00E+04		3.00E+04	T
4-chlorophenyl-phenylethe	7005-72-3												
4-Ethyltoluene	622-96-8									1.25E+05		1.25E+05	T
4-Methyl-2-Pentanone	108-10-1	8.34E+01	nc	7.30E+01	nc		7.30E+01	nc		3.00E+05		3.00E+05	T
4-methylphenol	106-44-5	1.83E+01	nc	1.83E+01	nc		1.83E+01	nc		2.00E+04		2.00E+04	T
4-nitroaniline	100-01-6									9.00E+03		9.00E+03	T
4-nitrophenol	100-02-7	2.92E+01	nc	2.90E+01	nc		2.90E+01	nc		2.50E+03		2.50E+03	T
4-Nitrotoluene	99-99-0	3.65E+01	nc	3.65E+01	nc		3.65E+01	nc		3.50E+04		3.50E+04	T
acenaphthene	83-32-9	2.19E+02	nc	2.19E+02	nc		2.19E+02	nc		1.25E+03		1.25E+03	T
Acenaphthylene	208-96-8									2.00E+02		2.00E+02	T
Acetaldehyde	75-07-0	8.73E-01	c	8.13E-01	c		8.13E-01	c	1.80E+04	1.50E+04		1.80E+04	E

Tuesday, August 14, 2001

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Substance	CAS#	PRG	Toxicity Endpoint	RBC	Toxicity Endpoint	NAAQS	HBSL Toxicity Endpoint	ERPG	TEEL	AEGL	ATV	ATV Source
Acetone	67-64-1	3.65E+02	nc	3.65E+02	nc		3.65E+02	nc	2.00E+06		2.00E+06	T
Acetonitrile	75-05-8	6.20E+01	nc	6.21E+01	nc		6.20E+01	nc	1.00E+05		1.00E+05	T
Acetylene	74-86-2											
Acrolein	107-02-8	2.09E-02	nc	2.08E-02	nc		2.08E-02	nc	2.30E+02		2.30E+02	E
Acrylonitrile	107-13-1	2.83E-02	c	2.61E-02	c		2.61E-02	c	2.17E+04		2.17E+04	E
Alpha Methyl Styrene	98-83-9	2.56E+02	nc	2.56E+02	nc		2.56E+02	nc				
Aluminum	7429-90-5	5.11E+00	nc	3.65E+00	nc		3.65E+00	nc	3.00E+04		3.00E+04	T
Ammonia (NH3)	7664-41-7	1.04E+02	nc	1.04E+02	nc		1.04E+02	nc	1.75E+04		1.75E+04	E
anthracene	120-12-7	1.10E+03	nc	1.10E+03	nc		1.10E+03	nc	6.00E+03		6.00E+03	T
Antimony	7440-36-0			1.46E+00	nc		1.46E+00	nc	1.50E+03		1.50E+03	T
Arsenic	7440-38-2	4.47E-04	c	4.15E-04	c		4.15E-04	c	3.00E+01		3.00E+01	T
Barium	7440-39-3	5.21E-01	nc	5.11E-01	nc		5.11E-01	nc	1.50E+03		1.50E+03	T
Benzaldehyde	100-52-7	3.65E+02	nc	3.65E+02	nc		3.65E+02	nc	1.50E+04		1.50E+04	T
Benzene	71-43-2	2.49E-01	c	2.16E-01	c		2.16E-01	c	1.56E+05		1.56E+05	E
benzo(a)anthracene	56-55-3	2.17E-02	c	8.58E-03	c		8.58E-03	c	6.00E+02		6.00E+02	T
benzo(a)pyrene	50-32-8	2.17E-03	c	2.02E-03	c		2.02E-03	c	6.00E+02		6.00E+02	T
benzo(b)fluoranthene	205-99-2	2.17E-02	c	8.58E-03	c		8.58E-03	c				
Benzo(e)pyrene	192-97-2											
benzo(g,h,i)perylene	191-24-2								3.00E+04		3.00E+04	T

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Substance	CAS#	PRG	Toxicity Endpoint	RBC	Toxicity Endpoint	NAAQS	HBSL Endpoint	Toxicity Endpoint	ERPG	TEEL	AEGL	ATV	ATV Source
benzo(k)fluoranthene	207-08-9	2.17E-01	c	8.58E-02	c		8.58E-02	c					
benzyl alcohol	100-51-6	1.10E+03	nc	1.10E+03	nc		1.10E+03	nc		6.00E+04		6.00E+04	T
Benzyl Chloride	100-44-7	3.96E-02	c	3.68E-02	c		3.68E-02	c	5.20E+03	5.00E+03		5.20E+03	E
Beryllium	7440-41-7	8.00E-04	c	7.45E-04	c		7.45E-04	c		5.00E+00		5.00E+00	T
bis(2-chloroethoxy)methan	111-91-1												
bis(2-chloroethyl)ether	111-44-4	5.82E-03	c	5.69E-03	c		5.69E-03	c		6.00E+04		6.00E+04	T
bis(2-chloroisopropyl)ether	108-60-1	1.92E-01	c	1.79E-01	c		1.79E-01	c		7.50E+04		7.50E+04	T
Bis(2-ethylhexyl)phthalate	117-81-7	4.80E-01	c	4.47E-01	c		4.47E-01	c		1.00E+04		1.00E+04	T
Bromobenzene	108-86-1	1.04E+01	nc							5.00E+04		5.00E+04	T
Bromodichloromethane	75-27-4	1.08E-01	c	1.01E-01	c		1.01E-01	c		4.00E+03		4.00E+03	T
Bromoform	75-25-2	1.75E+00	c	1.61E+00	c		1.61E+00	c		6.00E+03		6.00E+03	T
Bromomethane	74-83-9	5.21E+00	nc	5.11E+00	nc		5.11E+00	nc		1.00E+04		1.00E+04	T
butylbenzylphthalate	85-68-7	7.30E+02	nc	7.30E+02	nc		7.30E+02	nc		5.00E+05		5.00E+05	T
Butyraldehyde	123-72-8												
Cadmium	7440-43-9	1.07E-03	c	9.94E-04	c		9.94E-04	c		7.50E+04		7.50E+04	T
Calcium	7440-70-2									3.00E+01		3.00E+01	T
Carbon Dioxide (CO2)	124-38-9									3.00E+04		3.00E+04	T
Carbon Disulfide	75-15-0	7.30E+02	nc	7.30E+02	nc		7.30E+02	nc		5.00E+07		5.00E+07	T
Carbon Monoxide (CO)	630-08-0									3.00E+04		3.00E+04	T
						1.00E+04	1.00E+04	nc	2.30E+05	2.00E+05		2.30E+05	E

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Substance	CAS#	PRG	Toxicity Endpoint	RBC	Toxicity Endpoint	NAAQS	HBSL Toxicity Endpoint	ERPG	TEEL	AEGL	ATV	ATV Source
Carbon Tetrachloride	56-23-5	1.28E-01	c	1.18E-01	c		1.18E-01	c	1.28E+05	1.25E+05	1.28E+05	E
Chlorobenzene	108-90-7	6.21E+01	nc	6.21E+01	nc		6.21E+01	nc	1.25E+05	1.25E+05	1.25E+05	T
Chlorodifluoromethane	75-45-6	5.11E+04	nc	5.11E+04	nc		5.11E+04	nc	4.00E+06	4.00E+06	4.00E+06	T
Chloroethane	75-00-3	2.32E+00	c	2.16E+00	c		2.16E+00	c	2.50E+06	2.50E+06	2.50E+06	T
Chloroform	67-66-3	8.35E-02	c	7.73E-02	c		7.73E-02	c	1.00E+04	1.00E+04	1.00E+04	T
Chloromethane	74-87-3	1.07E+00	c	1.79E+00	c		1.07E+00	c	2.00E+05	2.00E+05	2.00E+05	T
Chromium	7440-47-3		c	1.53E-04	c		1.53E-04	c	1.50E+03	1.50E+03	1.50E+03	T
chrysene	218-01-9	2.17E+00	c	8.58E-01	c		8.58E-01	c	6.00E+02	6.00E+02	6.00E+02	T
cis-1,2-Dichloroethene	156-59-2	3.65E+01	nc	3.65E+01	nc		3.65E+01	nc	7.50E+05	5.54E+05	5.54E+05	A
cis-1,3-Dichloropropene	10061-01-5								1.25E+04	1.25E+04	1.25E+04	T
cis-butene	25167-67-3								2.00E+04	2.00E+04	2.00E+04	T
Cobalt	7440-48-4		nc	1.83E-02	nc		1.83E-02	nc	1.00E+02	1.00E+02	1.00E+02	T
Copper	7440-50-8		nc	1.46E+02	nc		1.46E+02	nc	3.00E+03	3.00E+03	3.00E+03	T
Crotonaldehyde	4170-30-3	3.54E-03	c						5.72E+03	6.00E+03	5.72E+03	E
Cumene	98-82-8	4.02E+02	nc	4.02E+02	nc		4.02E+02	nc	2.50E+05	2.50E+05	2.50E+05	T
dibenz(a,h)anthracene	53-70-3	2.17E-03	c	8.58E-04	c		8.58E-04	c	3.00E+04	3.00E+04	3.00E+04	T
dibenzofuran	132-64-9	1.46E+01	nc	1.46E+01	nc		1.46E+01	nc				
Dibromochloromethane	124-48-1	8.00E-02	c	7.45E-02	c		7.45E-02	c	6.00E+03	6.00E+03	6.00E+03	T
Dibromomethane	74-95-3	3.65E+01	nc	3.65E+01	nc		3.65E+01	nc	2.50E+05	2.50E+05	2.50E+05	T

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Substance	CAS#	PRG	Toxicity Endpoint	RBC	Toxicity Endpoint	NAAQS	HBSL	Toxicity Endpoint	ERPG	TEEL	AEGL	ATV	ATV Source
Dibutyl Phthalate	84-74-2	3.65E+02	nc	3.65E+02	nc		3.65E+02	nc		1.50E+04		1.50E+04	T
Dichlorodifluoromethane	75-71-8	2.09E+02	nc	1.83E+02	nc		1.83E+02	nc		1.50E+07		1.50E+07	T
diethylphthalate	84-66-2	2.92E+03	nc	2.92E+03	nc		2.92E+03	nc		1.50E+04		1.50E+04	T
dimethylphthalate	131-11-3	3.65E+04	nc	3.65E+04	nc		3.65E+04	nc		1.50E+04		1.50E+04	T
di-n-octylphthalate	117-84-0	7.30E+01	nc	7.30E+01	nc		7.30E+01	nc		1.50E+05		1.50E+05	T
Diphenylamine	122-39-4	9.13E+01	nc	9.13E+01	nc		9.13E+01	nc		3.00E+04		3.00E+04	T
Ethane	74-84-0												
Ethyl Acetate	141-78-6	3.29E+03	nc	3.29E+03	nc		3.29E+03	nc		1.50E+06		1.50E+06	T
Ethyl Acrylate	140-88-5	1.40E-01	c							6.00E+04		6.00E+04	T
Ethyl Methacrylate	97-63-2	3.29E+02	nc	3.29E+02	nc		3.29E+02	nc					
Ethylbenzene	100-41-4	1.06E+03	nc	1.06E+03	nc		1.06E+03	nc		5.00E+05		5.00E+05	T
Ethylene	74-85-1									5.00E+05		5.00E+05	T
fluoranthene	206-44-0	1.46E+02	nc	1.46E+02	nc		1.46E+02	nc		3.00E+01		3.00E+01	T
Fluorene	86-73-7	1.46E+02	nc	1.46E+02	nc		1.46E+02	nc		7.50E+04		7.50E+04	T
Formaldehyde	50-00-0	1.48E-01	c	1.39E-01	c		1.39E-01	c	1.23E+03	1.25E+03		1.23E+03	E
Freon 113	76-13-1	3.13E+04	nc	3.14E+04	nc		3.13E+04	nc		1.00E+07		1.00E+07	T
Freon 114	76-14-2									2.00E+07		2.00E+07	T
Heptane	142-82-5									1.50E+06		1.50E+06	T
hexachlorobenzene	118-74-1	4.18E-03	c	3.91E-03	c		3.91E-03	c		7.50E+01		7.50E+01	T

Substance	CAS#	PRG	Toxicity Endpoint	RBC	Toxicity Endpoint	NAAQS	HBSL	Toxicity Endpoint	ERPG	TEEL	AEGL	ATV	ATV Source
Hexachlorobutadiene	87-68-3	8.62E-02	c	8.03E-02	c		8.03E-02	c	3.21E+04	3.00E+04		3.21E+04	E
hexachlorocyclopentadien	77-47-4	7.30E-02	nc	7.30E-02	nc		7.30E-02	nc		1.00E+02		1.00E+02	T
Hexachloroethane	67-72-1	4.80E-01	c	4.47E-01	c		4.47E-01	c		3.00E+04		3.00E+04	T
Hexaldehyde	66-25-1												
Hexane	110-54-3	2.09E+02	nc	2.08E+02	nc		2.08E+02	nc		5.00E+05		5.00E+05	T
HMX	2691-41-0	1.83E+02	nc	1.83E+02	nc		1.83E+02	nc					
Hydrogen bromide	10035-10-6									1.00E+04		1.00E+04	T
Hydrogen chloride	7647-01-0	2.08E+01	nc	2.08E+01	nc		2.08E+01	nc	4.50E+03	4.00E+03	2.70E+03	2.70E+03	A
Hydrogen Cyanide	74-90-8	3.13E+00	nc	3.14E+00	nc		3.13E+00	nc		5.00E+03		5.00E+03	T
Hydrogen fluoride	7664-39-3								1.60E+03	1.50E+03	1.60E+03	1.60E+03	A
indeno(1,2,3-cd)pyrene	193-39-5	2.17E-02	c	8.58E-03	c		8.58E-03	c					
Isobutane	75-28-5									1.00E+06		1.00E+06	T
Isooctane	540-84-1									5.00E+05		5.00E+05	T
isophorone	78-59-1	7.08E+00	c	6.59E+00	c		6.59E+00	c		2.50E+04		2.50E+04	T
Isovaleraldehyde	590-86-3												
Lead	7439-92-1					2.00E+00	2.00E+00	nc		1.50E+02		1.50E+02	T
m/p-Xylene	108-38-3	7.30E+02	nc	7.30E+03	nc		7.30E+02	nc		6.00E+05		6.00E+05	T
Magnesium	7439-95-4									3.00E+04		3.00E+04	T
Manganese	7439-96-5	5.11E-02	nc	5.22E-02	nc		5.11E-02	nc		3.00E+03		3.00E+03	T

Substance	CAS#	PRG	Toxicity Endpoint	RBC	Toxicity Endpoint	NAAQS	HBSL	Toxicity Endpoint	ERPG	TEEL	AEGL	ATV	ATV Source
Methane	74-82-8									1.00E+07		1.00E+07	T
Methyl Acrylate	96-33-3	1.10E+02	nc	1.10E+02	nc		1.10E+02	nc					
Methyl Iodide	74-88-4								1.45E+05	1.50E+05		1.45E+05	E
Methyl Methacrylate	80-62-6	7.30E+02	nc	7.30E+02	nc		7.30E+02	nc		4.00E+05		4.00E+05	T
Methyl t-Butyl Ether	1634-04-4	3.13E+03	nc	3.13E+03	nc		3.13E+03	nc		4.00E+05		4.00E+05	T
Methylene Chloride	75-09-2	4.09E+00	c	3.79E+00	c		3.79E+00	c	6.96E+05	6.00E+05		6.96E+05	E
naphthalene	91-20-3	3.13E+00	nc	3.29E+00	nc		3.13E+00	nc		7.50E+04		7.50E+04	T
Nickel	7440-02-0			7.30E+01	nc		7.30E+01	nc		4.50E+03		4.50E+03	T
Nitric Acid	7697-37-2									2.50E+03	1.30E+03	1.30E+03	A
Nitrobenzene	98-95-3	2.09E+00	nc	2.19E+00	nc		2.09E+00	nc		1.50E+04		1.50E+04	T
Nitroglycerine	55-63-0	4.80E-01	c	4.47E-01	c		4.47E-01	c		1.00E+02		1.00E+02	T
n-nitrosodimethylamine	62-75-9	1.37E-04	c	1.23E-04	c		1.23E-04	c		1.00E+04		1.00E+04	T
n-nitroso-di-n-propylamine	621-64-7	9.61E-04	c	8.94E-04	c		8.94E-04	c		2.00E+02		2.00E+02	T
n-nitrosodiphenylamine(1)	86-30-6	1.37E+00	c	1.28E+00	c		1.28E+00	c		2.50E+04		2.50E+04	T
o,m,p-Tolualdehyde	1334-78-7												
OCDD	3268-87-9									1.50E+02		1.50E+02	T
OCDF	39001-02-0									3.00E+02		3.00E+02	T
Octane	111-65-9												
Oxides of Nitrogen (NOx)	10102-43-9			3.65E+02	nc	1.00E+02	1.00E+02	nc		3.00E+04		3.00E+04	T

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Substance	CAS#	PRG	Toxicity Endpoint	RBC	Toxicity Endpoint	NAAQS	HBSL	Toxicity Endpoint	ERPG	TEEL	AEGL	ATV	ATV Source
o-Xylene	95-47-6	7.30E+02	nc	7.30E+03	nc		7.30E+02	nc		6.00E+05		6.00E+05	T
Particulate Cyanide	57-12-5			7.30E+01	nc		7.30E+01	nc		5.00E+03		5.00E+03	T
Particulate Matter <10 micr PM10			nc			5.00E+01	5.00E+01	nc					
Particulate Matter <2.5 mic PM2.5			nc			1.50E+01	1.50E+01	nc					
pentachlorophenol	87-86-5	5.60E-02	c	5.22E-02	c		5.22E-02	c		5.00E+02		5.00E+02	T
Pentaerythritoltetranitrate	78-11-5									5.00E+01		5.00E+01	T
Pentane	109-66-0									1.50E+06		1.50E+06	T
phenanthrene	85-01-8									2.00E+03		2.00E+03	T
phenol	108-95-2	2.19E+03	nc	2.19E+03	nc		2.19E+03	nc		4.00E+04	1.70E+04	1.70E+04	A
Phosphoric acid	7664-38-2	1.04E+01	nc	1.06E+01	nc		1.04E+01	nc		3.00E+03		3.00E+03	T
Propane	74-98-6									3.50E+06		3.50E+06	T
Propionaldehyde	123-38-6									7.50E+04		7.50E+04	T
Propylene	115-07-1												
Propyne	74-99-7									2.50E+06		2.50E+06	T
pyrene	129-00-0	1.10E+02	nc	1.10E+02	nc		1.10E+02	nc		1.50E+04		1.50E+04	T
RDX	121-82-4	6.11E-02	c	5.69E-02	c		5.69E-02	c		3.00E+03		3.00E+03	T
Selenium	7782-49-2			1.83E+01	nc		1.83E+01	nc		6.00E+02		6.00E+02	T
Silver	7440-22-4			1.83E+01	nc		1.83E+01	nc		3.00E+02		3.00E+02	T
Styrene	100-42-5	1.06E+03	nc	1.04E+03	nc		1.04E+03	nc	2.13E+05	2.00E+05		2.13E+05	E

Substance	CAS#	PRG	Toxicity Endpoint	RBC	Toxicity Endpoint	NAAQS	HBSL	Toxicity Endpoint	ERPG	TEEL	AEGL	ATV	ATV Source
Sulfur Dioxide (SO2)	7446-09-5					8.00E+01	8.00E+01	nc	7.89E+02	7.50E+02		7.89E+02	E
Sulfuric Acid	7664-93-9								2.00E+03	2.00E+03		2.00E+03	E
tert-Butyl Alcohol	75-65-0									4.00E+05		4.00E+05	T
Tetrachloroethene	127-18-4	3.31E+00	c	3.13E+00	c		3.13E+00	c		6.00E+05	2.40E+05	2.40E+05	A
Tetryl	479-45-8	3.65E+01	nc	3.65E+01	nc		3.65E+01	nc		4.50E+03		4.50E+03	T
Thallium	7440-28-0			2.56E-01	nc		2.56E-01	nc		3.00E+02		3.00E+02	T
Toluene	108-88-3	4.02E+02	nc	4.16E+02	nc		4.02E+02	nc	1.88E+05	1.50E+05	3.00E+05	3.00E+05	A
Total Suspended Particulate 12789-66-1						5.00E+01	5.00E+01	nc					
trans-1,2-Dichloroethene	156-60-5	7.30E+01	nc	7.30E+01	nc		7.30E+01	nc		5.00E+04	1.11E+06	1.11E+06	A
trans-1,3-Dichloropropene	10061-02-6									1.25E+04		1.25E+04	T
Trichlorofluoromethane	75-69-4	7.30E+02	nc	7.30E+02	nc		7.30E+02	nc		2.50E+06		2.50E+06	T
Valeraldehyde	110-62-3												
Vanadium	7440-62-2			2.56E+01	nc		2.56E+01	nc		1.50E+02		1.50E+02	T
Vinyl Acetate	108-05-4	2.09E+02	nc	2.08E+02	nc		2.08E+02	nc	1.92E+04	1.50E+04		1.92E+04	E
Vinyl Chloride	75-01-4	2.17E-01	c	7.20E-02	c		7.20E-02	c		1.25E+04		1.25E+04	T
Zinc	7440-66-6			1.10E+03	nc		1.10E+03	nc		3.00E+04		3.00E+04	T

Substance	CAS#	PRG	Toxicity Endpoint	RBC	Toxicity Endpoint	NAAQS	HBSL	Toxicity Endpoint	ERPG	TEEL	AEGL	ATV	ATV Source
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CAS# = Chemical Abstract Service Number PRG = Preliminary Remediation Goal ($\mu\text{g}/\text{m}^3$) RBC = Risk-Based Concentration ($\mu\text{g}/\text{m}^3$) NAAQS = National Ambient Air Quality Standard ($\mu\text{g}/\text{m}^3$) HBSL = health-based screening level ($\mu\text{g}/\text{m}^3$) ERPG (E) = Emergency Response Planning Guideline ($\mu\text{g}/\text{m}^3$) TEEL (T) = Temporary Emergency Exposure Limit ($\mu\text{g}/\text{m}^3$) AEGL (A) = Acute Exposure Guideline Level ($\mu\text{g}/\text{m}^3$) c = carcinogen nc = noncarcinogen
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APPENDIX D

RISK ASSESSMENT DATA

Table D-1: Comparison of Modeled Air Concentrations with Health-Based Values

<i>M301A3 81-mm Illuminating Cartridge</i>		<i>Modeled Distance (meters) 100</i>			<i>DODIC: C226</i>		
<i>Substance*</i>	<i>CAS#</i>	<i>CONC</i>	<i>Cchronic</i>	<i>Cchr/HBSL</i>	<i>Cchr/HBSL>1?</i>	<i>Cacute</i>	<i>Cact/ATV Cact/ATV>1?</i>
1,1,1-Trichloroethane	71-55-6	6.60E-09	2.71E-05	2.60E-08	<input type="checkbox"/>	9.16E-03	7.33E-09 <input type="checkbox"/>
1,2,4-Trimethylbenzene	95-63-6	3.37E-09	1.39E-05	2.23E-06	<input type="checkbox"/>	1.87E-02	1.04E-07 <input type="checkbox"/>
1,2-Dichloroethane	107-06-2	2.35E-08	4.13E-05	6.00E-04	<input type="checkbox"/>	1.30E-01	1.74E-05 <input type="checkbox"/>
1,3,5-Trimethylbenzene	108-67-8	1.90E-09	7.80E-06	1.26E-06	<input type="checkbox"/>	1.06E-02	8.44E-08 <input type="checkbox"/>
1,3-Butadiene	106-99-0	1.28E-08	2.26E-05	6.49E-03	<input type="checkbox"/>	1.78E-02	8.09E-07 <input type="checkbox"/>
1234678-HPCHD	35822-46-9	1.57E-14	6.47E-11		<input type="checkbox"/>	8.74E-08	1.46E-10 <input type="checkbox"/>
1234678-HPCHD	67562-39-4	1.28E-15	5.26E-12		<input type="checkbox"/>	7.11E-09	4.74E-11 <input type="checkbox"/>
2-Butanone	78-93-3	3.04E-09	1.25E-05	1.20E-08	<input type="checkbox"/>	1.69E-02	2.25E-08 <input type="checkbox"/>
4-Ethyltoluene	622-96-8	2.22E-09	9.10E-06		<input type="checkbox"/>	1.23E-02	9.85E-08 <input type="checkbox"/>
Acenaphthene	83-32-9	2.11E-10	8.66E-07	3.96E-09	<input type="checkbox"/>	1.17E-03	9.37E-07 <input type="checkbox"/>
Acenaphthylene	208-96-8	6.72E-09	2.76E-05		<input type="checkbox"/>	3.73E-02	1.87E-04 <input type="checkbox"/>
Acetaldehyde	75-07-0	1.86E-07	3.27E-04	4.03E-04	<input type="checkbox"/>	2.58E-01	1.43E-05 <input type="checkbox"/>
Acetone	67-64-1	1.28E-08	5.27E-05	1.44E-07	<input type="checkbox"/>	7.13E-02	3.56E-08 <input type="checkbox"/>
Acetonitrile	75-05-8	4.68E-08	1.92E-04	3.10E-06	<input type="checkbox"/>	2.60E-01	2.60E-06 <input type="checkbox"/>
Acetylene	74-86-2	6.88E-07	2.83E-03		<input type="checkbox"/>	9.56E-01	<input type="checkbox"/>
Acrolein	107-02-8	1.00E-07	4.13E-04	1.98E-02	<input type="checkbox"/>	1.39E-01	6.06E-04 <input type="checkbox"/>
Acrylonitrile	107-13-1	2.38E-08	4.18E-05	1.60E-03	<input type="checkbox"/>	3.30E-02	1.52E-06 <input type="checkbox"/>
Alpha Methyl Styrene	98-83-9	1.87E-09	7.67E-06	3.00E-08	<input type="checkbox"/>	2.59E-03	<input type="checkbox"/>

M301A3 81-mm Illuminating Cartridge		Modeled Distance (meters) 100				DODIC: C226			
Substance*	CAS#	CONC	Cclhronic	Cchr/HBSL	Cchr/HBSL	Cact/ATV	Cact/ATV	Cact/ATV	Cact/ATV>1?
Aluminum	7429-90-5	4.44E-07	1.82E-03	5.00E-04		2.47E+00	8.22E-05		
Anthracene	120-12-7	2.69E-10	1.11E-06	1.01E-09		1.49E-03	2.49E-07		
Antimony	7440-36-0	1.49E-08	6.12E-05	4.20E-05		8.28E-02	5.52E-05		
Benzene	71-43-2	1.52E-06	2.67E-03	1.24E-02		2.11E+00	1.35E-05		
Benzo(a)anthracene	56-55-3	2.28E-10	4.02E-07	4.68E-05		1.27E-03	2.11E-06		
Benzo(a)pyrene	50-32-8	2.51E-10	4.42E-07	2.19E-04		1.39E-03	2.32E-06		
Benzo(b)fluoranthene	205-99-2	5.82E-10	1.02E-06	1.19E-04		8.08E-04			
Benzo(e)pyrene	192-97-2	4.29E-10	1.76E-06			5.95E-04			
Benzo(g,h,i)perylene	191-24-2	4.33E-10	1.78E-06			2.41E-03	8.02E-08		
Benzo(k)fluoranthene	207-08-9	3.60E-10	6.35E-07	7.40E-06		5.01E-04			
Bis(2-ethylhexyl)phthalate	117-81-7	1.66E-08	2.92E-05	6.53E-05		9.20E-02	9.20E-06		
Butyraldehyde	123-72-8	1.29E-07	5.30E-04			7.16E-01	9.55E-06		
Carbon Dioxide (CO2)	124-38-9	5.33E-04	2.19E+00			2.96E+03	5.92E-05		
Carbon Disulfide	75-15-0	3.01E-09	1.24E-05	1.69E-08		1.67E-02	5.57E-07		
Carbon Monoxide (CO)	630-08-0	5.23E-04	2.15E+00	2.15E-04		7.27E+02	3.16E-03		
Chloromethane	74-87-3	2.37E-10	4.17E-07	3.90E-07		1.31E-03	6.57E-09		
Chrysene	218-01-9	5.70E-10	1.00E-06	1.17E-06		3.17E-03	5.28E-06		
Copper	7440-50-8	3.71E-07	1.52E-03	1.04E-05		2.06E+00	6.86E-04		
Cumene	98-82-8	1.90E-09	7.80E-06	1.94E-08		1.05E-02	4.22E-08		

M301A3 81-mm Illuminating Cartridge Modeled Distance (meters) 100 DODIC: C226

Substance*	CAS#	CONC	Cchronic	Cchr/HBSL	Cchr/HBSL>I?	Cacute	Cact/ATV	Cact/ATV>I?
Dibenz(a,h)anthracene	53-70-3	6.83E-11	1.20E-07	1.40E-04	<input type="checkbox"/>	3.80E-04	1.27E-08	<input type="checkbox"/>
Dibutyl phthalate	84-74-2	1.76E-08	7.23E-05	1.98E-07	<input type="checkbox"/>	9.78E-02	6.52E-06	<input type="checkbox"/>
Ethylbenzene	100-41-4	8.57E-09	3.52E-05	3.33E-08	<input type="checkbox"/>	4.76E-02	9.52E-08	<input type="checkbox"/>
Ethylene	74-85-1	9.04E-07	3.72E-03		<input type="checkbox"/>	5.02E+00	1.00E-05	<input type="checkbox"/>
Fluoranthene	206-44-0	4.16E-10	1.71E-06	1.17E-08	<input type="checkbox"/>	2.31E-03	7.70E-05	<input type="checkbox"/>
Fluorene	86-73-7	1.49E-09	6.12E-06	4.19E-08	<input type="checkbox"/>	8.27E-03	1.10E-07	<input type="checkbox"/>
Formaldehyde	50-00-0	8.24E-07	1.45E-03	1.04E-02	<input type="checkbox"/>	1.14E+00	9.31E-04	<input type="checkbox"/>
Heptane	142-82-5	1.58E-09	6.51E-06		<input type="checkbox"/>	8.80E-03	5.86E-09	<input type="checkbox"/>
Hexane	110-54-3	5.14E-08	2.11E-04	1.02E-06	<input type="checkbox"/>	2.86E-01	5.71E-07	<input type="checkbox"/>
Hydrogen Cyanide	74-90-8	7.19E-08	2.95E-04	9.43E-05	<input type="checkbox"/>	3.99E-01	7.98E-05	<input type="checkbox"/>
Indeno(1,2,3-cd)pyrene	193-39-5	3.84E-10	6.77E-07	7.89E-05	<input type="checkbox"/>	5.34E-04		<input type="checkbox"/>
Lead	7439-92-1	2.89E-08	1.19E-04	5.93E-05	<input type="checkbox"/>	1.60E-01	1.07E-03	<input type="checkbox"/>
m/p-Xylene	108-38-3 106-4	9.11E-09	3.75E-05	5.13E-08	<input type="checkbox"/>	5.06E-02	8.44E-08	<input type="checkbox"/>
Manganese	7439-96-5	1.60E-08	6.56E-05	1.28E-03	<input type="checkbox"/>	8.87E-02	2.96E-05	<input type="checkbox"/>
Methane	74-82-8	1.66E-06	6.83E-03		<input type="checkbox"/>	9.23E+00	9.23E-07	<input type="checkbox"/>
Methyl Methacrylate	80-62-6	2.11E-09	8.67E-06	1.19E-08	<input type="checkbox"/>	1.17E-02	2.93E-08	<input type="checkbox"/>
Methyl t-Butyl Ether	1634-04-4	1.48E-09	6.10E-06	1.95E-09	<input type="checkbox"/>	8.24E-03	2.06E-08	<input type="checkbox"/>
Methylene Chloride	75-09-2	5.93E-08	1.04E-04	2.76E-05	<input type="checkbox"/>	8.24E-02	1.18E-07	<input type="checkbox"/>
Naphthalene	91-20-3	5.09E-08	2.09E-04	6.68E-05	<input type="checkbox"/>	2.83E-01	3.77E-06	<input type="checkbox"/>

M301A3 81-mm Illuminating Cartridge		Modeled Distance (meters) 100			DODIC: C226			
Substance*	CAS#	CONC	Cchronic	Cchr/HBSL	Cchr/HBSL>1?	Cacute	Cact/ATV	Cact/ATV>1?
Nickel	7440-02-0	2.87E-08	1.18E-04	1.62E-06	<input type="checkbox"/>	1.59E-01	3.54E-05	<input type="checkbox"/>
Nitroglycerine	55-63-0	2.48E-08	4.37E-05	9.77E-05	<input type="checkbox"/>	1.38E-01	1.38E-03	<input type="checkbox"/>
OCDD	3268-87-9	8.65E-14	3.56E-10		<input type="checkbox"/>	4.81E-07	3.20E-09	<input type="checkbox"/>
OCDF	39001-02-0	1.98E-15	8.13E-12		<input type="checkbox"/>	1.10E-08	3.66E-11	<input type="checkbox"/>
Oxides of Nitrogen (NOx)	10102-43-9	8.66E-06	3.56E-02	3.56E-04	<input type="checkbox"/>	4.81E+01	1.60E-03	<input type="checkbox"/>
o-Xylene	95-47-6	9.11E-09	3.75E-05	5.13E-08	<input type="checkbox"/>	5.06E-02	8.44E-08	<input type="checkbox"/>
Particulate Cyanide	57-12-5	1.08E-07	4.45E-04	6.09E-06	<input type="checkbox"/>	6.01E-01	1.20E-04	<input type="checkbox"/>
Particulate Matter <10 micron	PM10	3.44E-05	1.41E-01	2.83E-03	<input type="checkbox"/>	4.77E+01		<input type="checkbox"/>
Particulate Matter <2.5 micron	PM2.5	2.81E-05	1.16E-01	7.70E-03	<input type="checkbox"/>	3.91E+01		<input type="checkbox"/>
Pentane	109-66-0	1.57E-09	6.45E-06		<input type="checkbox"/>	8.72E-03	5.81E-09	<input type="checkbox"/>
Phenanthrene	85-01-8	1.57E-09	6.47E-06		<input type="checkbox"/>	8.75E-03	4.37E-06	<input type="checkbox"/>
Phenol	108-95-2	1.29E-08	5.30E-05	2.42E-08	<input type="checkbox"/>	1.79E-02	1.05E-06	<input type="checkbox"/>
Propylene	115-07-1	1.34E-07	5.51E-04		<input type="checkbox"/>	1.86E-01		<input type="checkbox"/>
Propyne	74-99-7	5.35E-08	2.20E-04		<input type="checkbox"/>	2.97E-01	1.19E-07	<input type="checkbox"/>
Pyrene	129-00-0	2.72E-10	1.12E-06	1.02E-08	<input type="checkbox"/>	1.51E-03	1.01E-07	<input type="checkbox"/>
Styrene	100-42-5	2.48E-07	1.02E-03	9.76E-07	<input type="checkbox"/>	3.45E-01	1.62E-06	<input type="checkbox"/>
Sulfuric Acid	7664-93-9	3.48E-07	1.43E-03		<input type="checkbox"/>	4.83E-01	2.42E-04	<input type="checkbox"/>
Toluene	108-88-3	1.05E-07	4.31E-04	1.07E-06	<input type="checkbox"/>	1.46E-01	4.86E-07	<input type="checkbox"/>
Total Suspended Particulate	12789-66-1	3.24E-05	1.33E-01	2.66E-03	<input type="checkbox"/>	4.50E+01		<input type="checkbox"/>

Tuesday, August 14, 2001

M301A3 81-mm Illuminating Cartridge

Modeled Distance (meters) 100

DODIC: C226

Substance*	CAS#	CONC	Cchronic	Cchr/HBSL	Cchr/HBSL>1?	Cacute	Cact/ATV	Cact/ATV>1?
Trichlorofluoromethane	75-69-4	1.41E-10	5.80E-07	7.94E-10	<input type="checkbox"/>	7.84E-04	3.14E-10	<input type="checkbox"/>
Zinc	7440-66-6	1.76E-06	7.23E-03	6.60E-06	<input type="checkbox"/>	9.77E+00	3.26E-04	<input type="checkbox"/>

* = Only substances detected in the Firing Point Emission Study are presented in this Appendix. In situations where the substance was detected using more than one sampling method, the higher concentration was used in the risk assessment to maintain a conservative approach.

DODIC = Department of Defense Identification Code

CAS# = Chemical Abstract Service Number

CONC = average modeled concentration for one cartridge (g/m³)

Cchronic = chronic time-averaged concentration (µg/m³)

HBSL = chronic health-based screening level (µg/m³)

Cacute = acute time-averaged concentration (µg/m³)

ATV = acute toxicity value (µg/m³)

Table D-2: Comparison of Modeled Air Concentrations with Health-Based Values: Total Petroleum Hydrocarbons

<i>M301A3 81-mm Illuminating Cartridge</i>	<i>Modeled Distance (meters)</i>	<i>100</i>	<i>DODIC: C226</i>
<i>Substance*</i>	<i>CAS#</i>	<i>Cchronic Aliphatic:<=8</i>	<i>Cchronic Aromatic:>8</i>
1,2,4-Trimethylbenzene	95-63-6		1.39E-05
1,3,5-Trimethylbenzene	108-67-8		7.80E-06
1,3-Butadiene	106-99-0	2.26E-05	
4-Ethyltoluene	622-96-8		9.10E-06
Acenaphthene	83-32-9		8.66E-07
Acenaphthylene	208-96-8		2.76E-05
Alpha Methyl Styrene	98-83-9		7.67E-06
Anthracene	120-12-7		1.11E-06
Benzene	71-43-2		2.67E-03
Benzo(a)anthracene	56-55-3		4.02E-07
Benzo(a)pyrene	50-32-8		4.42E-07
Benzo(b)fluoranthene	205-99-2		1.02E-06
Benzo(e)pyrene	192-97-2		1.76E-06
Benzo(g,h,i)perylene	191-24-2		1.78E-06
Benzo(k)fluoranthene	207-08-9		6.35E-07
Chrysene	218-01-9		1.00E-06
Cumene	98-82-8		7.80E-06

<i>M301A3 81-mm Illuminating Cartridge</i>		<i>Modeled Distance (meters)</i>		<i>100</i>	<i>DODIC: C226</i>
<i>Substance*</i>	<i>CAS#</i>	<i>Cchronic Aliphatic:<=8</i>	<i>Cchronic Aliphatic:>8</i>	<i>Cchronic Aromatic:<=8</i>	<i>Cchronic Aromatic:>8</i>
Dibenz(a,h)anthracene	53-70-3				1.20E-07
Ethylbenzene	100-41-4			3.52E-05	
Fluoranthene	206-44-0				1.71E-06
Fluorene	86-73-7				6.12E-06
Heptane	142-82-5	6.51E-06			
Hexane	110-54-3	2.11E-04			
Indeno(1,2,3-cd)pyrene	193-39-5				6.77E-07
m/p-Xylene	108-38-3 1			3.75E-05	
Naphthalene	91-20-3				2.09E-04
o-Xylene	95-47-6			3.75E-05	
Pentane	109-66-0	6.45E-06			
Phenanthrene	85-01-8				6.47E-06
Propylene	115-07-1	5.51E-04			
Propyne	74-99-7	2.20E-04			
Pyrene	129-00-0				1.12E-06
Styrene	100-42-5				1.02E-03
Toluene	108-88-3			4.31E-04	

M301A3 81-mm Illuminating Cartridge		Modeled Distance (meters)		100		DODIC: C226	
Substance*	CAS#	Cchronic Aliphatic:<=8	Cchronic Aliphatic:>8	Cchronic Aromatic:<=8	Cchronic Aromatic:>8		
Total (µg/m³)		1.02E-03		3.22E-03	1.33E-03		
Derived Health-Based Screening Level (µg/m³)		1.92E+04	1.04E+03	4.17E+02	2.09E+02		
Cchronic/HBSL		5.30E-08		7.71E-06	6.35E-06		
Is this ratio >1?		No	No	No	No		

* = Only substances detected in the Firing Point Emission Study are presented in this Appendix. In situations where the substance was detected using more than one sampling method, the higher concentration was used in the risk assessment to maintain a conservative approach.

DODIC = Department of Defence Identification Code

CAS# = Chemical Abstract Service Number

Cchronic = chronic time-averaged concentration (µg/m³)

HBSL = chronic health-based screening level (µg/m³)

APPENDIX E

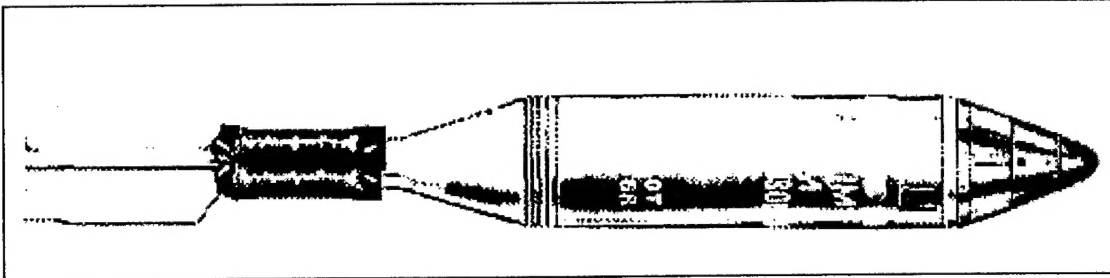
FACT SHEET SUBMITTED TO THE
U.S. ARMY ENVIRONMENTAL CENTER

U.S. Army Environmental Center

Training Munitions Fact Sheet

M301A3 81-mm Illuminating Cartridge

Department of Defense Identification Code: C226



Breathing air emissions from firing of the M301A3 81-mm Illuminating Cartridge will not impact the health of residents who live near Army training facilities.

To be fully prepared to protect our country, U.S. soldiers must train with many different weapons and munitions, including the M301A3 81-mm Illuminating Cartridge (M301A3). This training is important because it helps prepare our soldiers for a variety of combat situations. While the Army recognizes the value of such comprehensive training on our installations, we also work hard to ensure the safety and health of surrounding communities.

WILL BREATHING AIR EMISSIONS FROM FIRING THE M301A3 81-MM ILLUMINATING CARTRIDGE AFFECT MY HEALTH?

To answer this question, the U.S. Army tested the air emissions that are released when the M301A3 is fired. The information gathered during these tests was then analyzed to determine if there would be a potential for health effects from inhalation to residents who live near training areas. Study results, generated using conservative methods, showed that offsite residents breathing air as close as 100 meters (328 feet or about the length of a football field) from the firing location are safe from these emissions. At most locations, training areas are at least 1,000 meters (over half a mile) away from populated areas and the distance to firing locations may be even farther.

HOW WAS THE STUDY CONDUCTED?

To gather data for this study, the M301A3 was fired from an M252 mortar in a test chamber. The air in the chamber was then tested to identify the types and amounts of substances released. About 200 different substances were looked for during this part of the study.

This information was then used in an U.S. Environmental Protection Agency (EPA) approved air model (a computer program that allows estimation of air concentrations) to determine the amount of each substance to which someone living near a training site might be exposed. Downwind concentrations were estimated based on a typical use scenario for the M301A3 during training exercises. Since this study did not look at any one specific training area, the assumptions used in the model would, in most cases, predict higher downwind air concentrations than those expected at an actual training site.

These estimated air concentrations were then compared to screening levels established by the EPA and other federal agencies. If the air concentrations are below these screening levels, they are considered safe for the general population, including sensitive people such as the sick, elderly, and children.

WHAT ARE THE STUDY LIMITATIONS?

Many steps were taken to ensure that the results of this study are protective of residents who live near training facilities. However, as with any study, this study has limitations. For example, the study does not consider exposure to other types of munitions that could also be used during the same training event or exposure to emissions resulting from down range functioning of the item. Due to these limitations, conservative model conditions were used to ensure the protection of public health from breathing M301A3 air emissions.

WHAT EXACTLY IS THE M301A3 81-MM ILLUMINATING CARTRIDGE?

The M301A3 cartridge is used for illuminating a desired point or area. It is used during training and in combat. Each M301A3 cartridge provides illumination for at least 60 seconds.

WHERE CAN I GET MORE INFORMATION?

For more information on the M301A3 or other military munitions, please call the Army Environmental Hotline at 1-800-USA-3845, visit our Web site at www.aec.army.mil, or e-mail t2hotline@aec.apgea.army.mil.